SCIENTIFIC AMERICAN SUPPLEMENT No 65

Scientific American Supplement, Vol. III, No. 65.
Scientific American, established 1845.

NEW-YORK, MARCH 31, 1877.

Scientific American Supplement $5 a year.
Scientific American and Supplement, $7 a year.

COMPOUND CORLISS ENGINE.

We illustrate a patent compound Corliss beam engine recently built by Messrs. Douglas & Grant, Kirkcaldy, Eng., who have had much experience in this class of work.

The high-pressure cylinder is 26 in. diameter, and 30 in. stroke, having Corliss valves and gear of the most improved description. There are separate eccentrics for the steam and exhaust valves, thus insuring a very perfect distribution of steam. These eccentrics are carried on a horizontal shaft, driven by mitre gear from the crank shaft; this horizontal shaft terminates in a disk, in which a pin is fitted, to give motion to the valves of the low pressure cylinder, by connecting rods and a rocking lever under the floor.

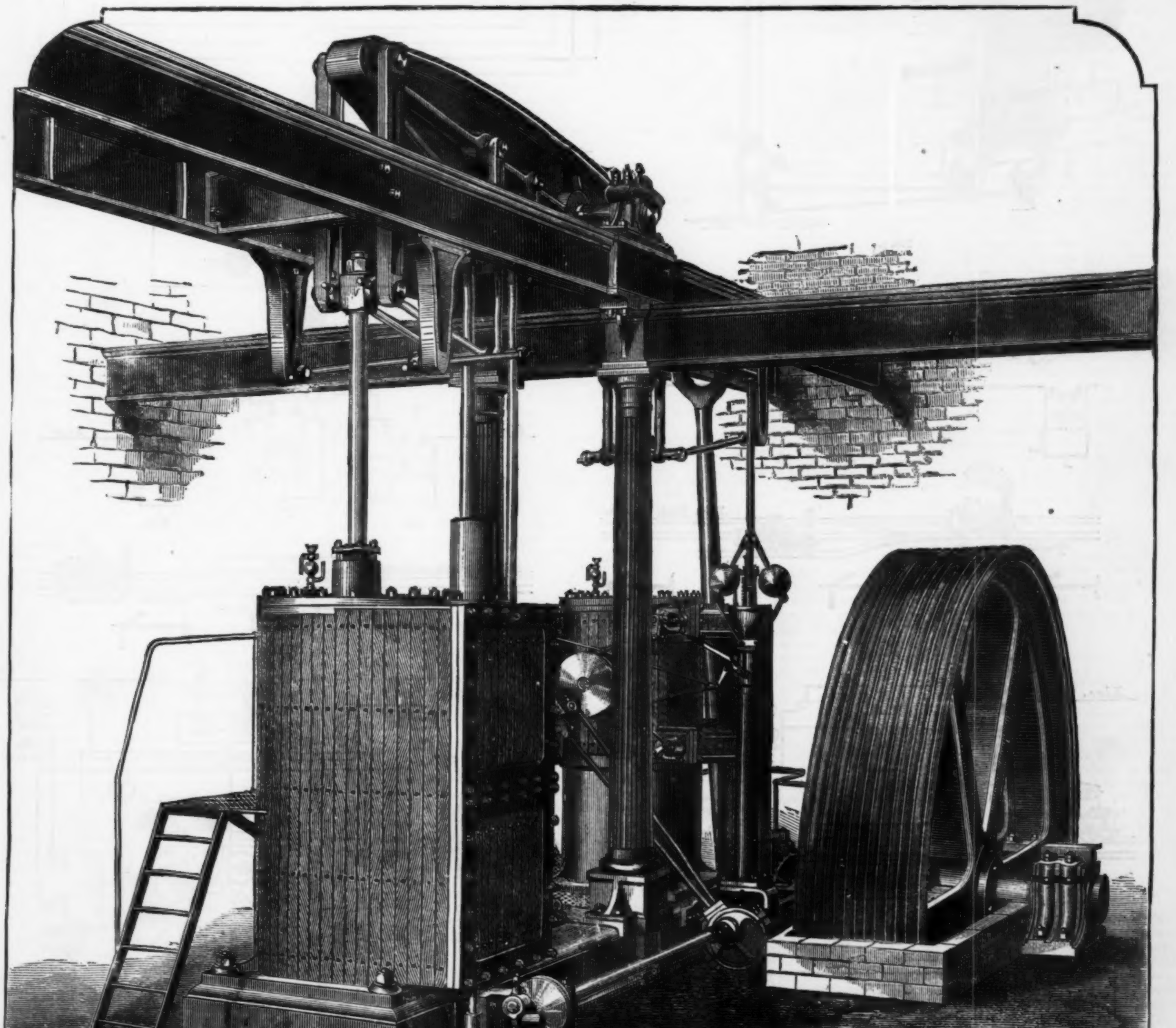
The low-pressure cylinder is 33 in. diameter, and 5 ft. stroke, and has two slide valves connected. These valves are backed with equilibrium plates, and a small piston, fixed on the upper end of the valve spindle, working in a cylinder, balances the weight of the valves, spindle, and rods; the upper portion of the cylinder being in communication with the condenser, and the lower portion with the valve casing.

The bed plate is very massive, 15 in. deep, and well proportioned, the brasses of the crank shaft neck being fitted into a slotted-out recess. The ends of entablature and spring beams are built into the walls of the engine house, and supported under the main gudgeons of the head by a pair of well got up fluted columns. The beam is 16 ft. between centers; the air-pump is 20 in. diameter and 30 in. stroke; the feed pump, 4¾ in. diameter and 12 in. stroke; the piston rods which are 3¾ in. diameter, and the crank pin 5¾ in. diameter, are of steel; the crank shaft, crank, and connecting rod, are of best forged iron; the necks of the shaft being 12 in. diameter and 18 in. long; and the central boss for fly-wheel 15¼ in. diameter.

The fly-wheel is 16 ft. diameter and 12 tons weight, turned upon rim and edges, with twelve V-shaped grooves for hemp ropes, through which the power of the engine is transmitted. This method of driving has come into somewhat extensive use, especially in Scotland, and has several advantages. There is, it is stated, an entire absence of noise, and of any tendency to backlash; and upright shafts are often dispensed with, by carrying a portion of the ropes to the horizontal shafts in the various flats of a mill.—*Engineer.*

REMARKABLE OCEAN STEAMING.

The steamship St. Osyth, one of the well-known Australian line of steamers belonging to Messrs. Watts, Milburn & Co., has recently been making a run which is highly creditable to the progress of marine engineering in general and to the makers of her engines—Messrs. R. & W. Hawthorn, of Newcastle, in particular. The last voyage of the St. Osyth from Plymouth to Melbourne and back to the Downs occupied four months and five days, the outward run being made in 45 days less some hours of actual time, the total stoppages in these runs being about three hours, caused by some boiler tubes giving way singly at different times. These tubes had been scaled when the vessel was in port, and may have been then injured. The homeward run from Melbourne to the Downs was made in 51 days, this including the time of coaling at Cape Verde, and the actual time under steam being under 49 days. From Melbourne to Cape Verde a continuous run of over 40 days was made without the engines being stopped for any cause whatever, and had it not been for the necessity of coaling the run might have been made home. On the outward voyage the daily consumption of coal was 33¼ tons,



ENGLISH STYLE CORLISS COMPOUND ENGINE.—BY DOUGLAS & GRANT.

Fig. 1.

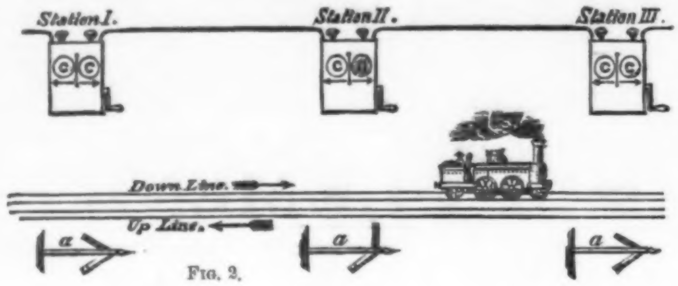
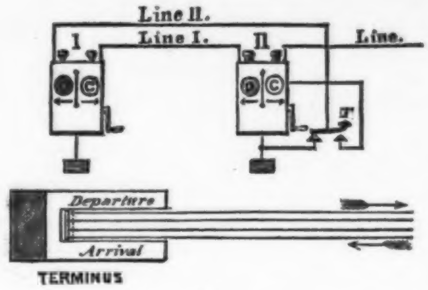


Fig. 2.



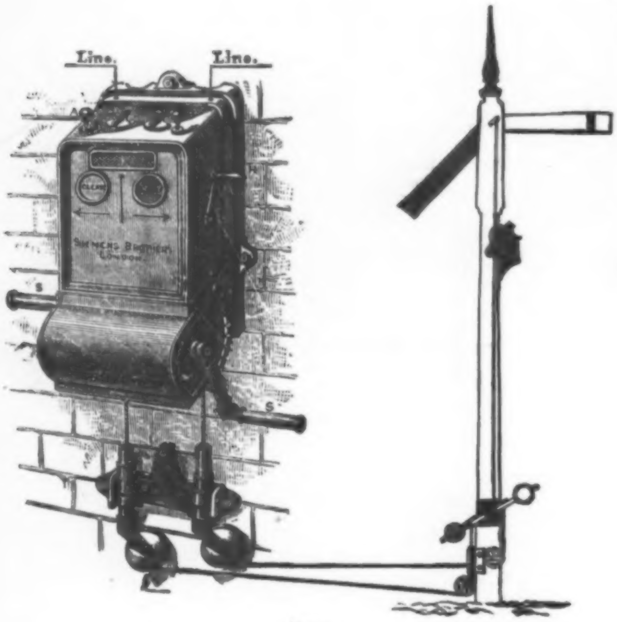


Fig. 3.

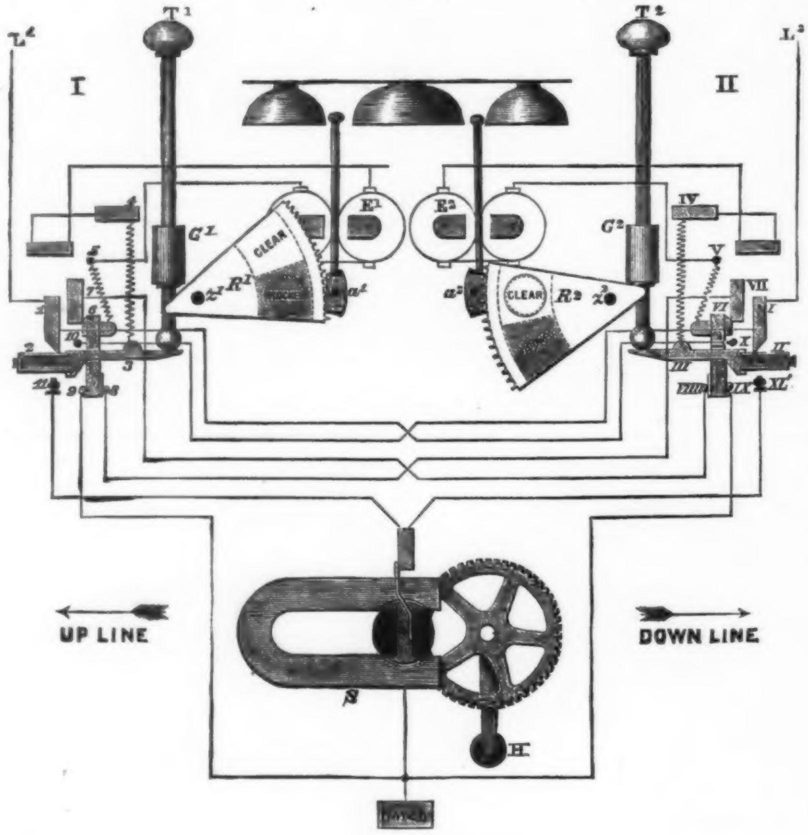
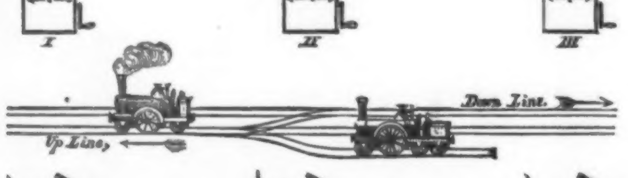
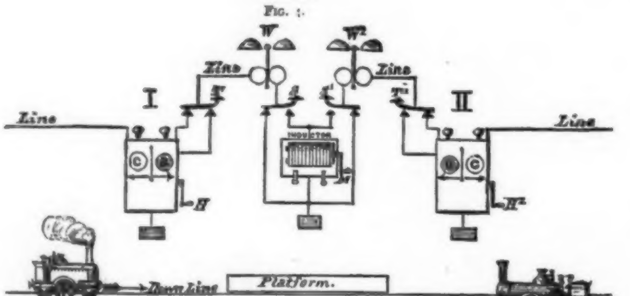


Fig.





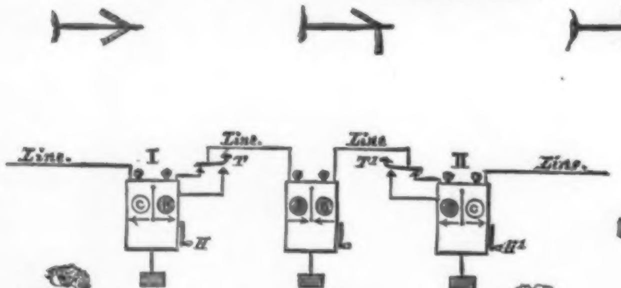


Fig. 7.

DISTANT SIGNAL.

Fig. 6.

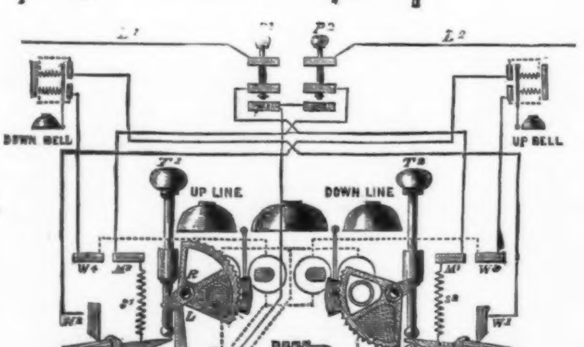


Fig. 10.

THE SIEMENS AND HALSKE SYSTEM OF ELECTRICAL RAILWAY SIGNALS.

and on the voyage home 34 tons, the latter being Australian Bull-eye coal. Altogether the performance is an admirable one. The St. Osyth was built in 1874 by Messrs. C. Mitchell & Co., of Low Walker; she carries 4,000 tons dead weight, and her engines are 500 horse power nominal.

SIEMENS AND HALSKE'S ELECTRICAL RAILWAY SIGNALS.

IN the improved form of block apparatus, a perspective view of which is shown at Fig. 1, the protecting case is entirely of iron, and may be put in communication with the earth for preventing any danger from lightning to the man working the apparatus. The handle, H, of the indicator is at the right hand side, and the two plungers, A and B, are at the top of the case. These plungers, or transmitting keys, serve as line-circuit closers, and when pressed down, produce the signal "line blocked" at the apparatus itself, thus sending the induction current to the preceding block station; the direction of the trains is marked by arrows. If the handle, H, of the instrument be turned, and at the same time the plunger A, on the left side of the instrument, be pressed down, the word "clear" becomes changed to "blocked," thus showing that the up-line is closed; and in the same way, if the plunger B were depressed, the right hand aperture would show that the down-line was blocked.

The signals given by electricity must be transferred to a standard signal visible to the engine driver, so that the signalman has not only to give the electrical signal, but also to work the visible standard signals. Let *a a a* (Fig. 2) represent these signals; when a train is proceeding on the down-line from station II. to station III., the signals should stand as shown in the engraving. If the apparatus were so constructed that a negligent signalman could omit to put his standard signal at "line blocked" after having given the electric signal, thereby clearing the preceding station, a collision might take place on the arrival of the succeeding train; but, as the man is unable to give the electric signal until he has put his semaphore at "danger," an accident is impossible, and delay only can ensue. The arrangement whereby a signalman is prevented from clearing the preceding block station before he has blocked the line with his semaphore, is shown at Fig. 3. In this case a winch is added to the bottom of the block apparatus, which may be placed in any convenient position inside the signal box, and this winch is so connected mechanically with the semaphore that, while the latter stands at "clear," it is impossible to give an electrical signal. By turning the handles S S, corresponding with the up and down lines, the semaphore arms are raised or lowered. In order to send an electrical signal to the preceding station (which is always the "clear" signal) it is necessary that the standard signal be first put to "danger," and an electrical "clear" signal sent to the preceding station during this "line blocked" position of the semaphore, not only blocks the electrical apparatus, but also interlocks the standard "blocked" signal, so that the standard "clear" signal can only be given after the electrical "blocked" signal has been changed into "clear" by the forward station.

The working of the electrical block apparatus is shown at Fig. 4, which represents two indices, identically the same for up and down lines, constituting one of the signalling instruments. To take No. 1, or that for the up-line, R_1, is a movable arm pivoted at 2_1, and provided with teeth on its periphery. The movement of this index up or down brings the words "blocked" or "clear" opposite the aperture in the case. The pallets of an escapement, a_1, similar to that used in clocks, engage in the teeth of the arm R_1. This escapement is attached to and worked by the polarized armature of an electro-magnet, E^1, and is caused to oscillate by a number of successive alternating positive and negative electrical currents. The arm, R^1, has, by its own weight, a tendency to fall, but, being held by the pallets of the escapement when they are at rest, it can only fall tooth by tooth when these pallets oscillate. As several alternating positive and negative currents in succession are required to give a number of oscillations sufficient to change the signal, an accidental current, a succession of currents of the same direction, or a discharge of atmospheric electricity, cannot change the signal. The armature connected to the escapement a^1 is polarized, so that the alternating positive and negative currents transmitted through the coils of the magnet E^1, cause it to oscillate. This oscillation, besides working the escapement, causes a hammer attached to the armature to strike the bells placed near it. To move the arm R^1 up again, a plunger, T^1, with a sliding weight, G^1, bearing upon the tail of the arm, is pressed down, thus giving the arm a tendency to rise as soon as the armature, a^1, oscillates. The plunger, T^1, also acts upon a commutator and determines the course the electrical currents have then to take.

The following example will serve to show the reciprocal operation between the block apparatus of two neighboring stations. In Fig. 4, the up-line is blocked, a train having just passed. As soon as that train passes the next station, the signalman then presses down his up line plunger, at the same time turning the handle of his magneto-inductor. By these two operations he blocks his up-line apparatus, and also sends alternate positive and negative currents along the line wire, L^1, and through the conducting parts marked 1, 2, 3, 4, to the coils of E^1, and thence through 5, 6, 7, *VIII.* and *IX.* to earth, thus causing the escapement, a^1, to oscillate. During this oscillation the arm R^1 descends, tooth by tooth, and brings before the aperture in the cover of the instrument the word "clear," while the word "blocked" becomes hidden behind the cover. A similar action takes place for the down-line indicator, marked II., when the currents are transmitted to L^2.

The apparatus above described, always interlocks with the standard signal, serves for block stations between railway stations where there are no points or sidings; it is also sufficient for small railway stations, but will require a few more manipulations for the blocking and clearing of the line when a goods or slow train has to be shunted, to allow an express or fast train to pass. At Fig. 5, *II.* shows a siding at a railway station, into which it is necessary to shunt a goods train to allow an express, one stage behind, to pass. When the goods train is shunted, the signalman at station *II.* blocks his up-line, thereby clearing station *III.* Before the express could pass station *III.*, its apparatus should show the signal "line clear." As this effect, when produced in the ordinary way, by turning the handle of the magneto-inductor and pressing down the corresponding plunger to "danger" at station *II.*, would involve the signal "line clear" at station *III.*, and so forbid the express to pass station *II.*, it becomes necessary to open the aperture at the top of the apparatus at station *II.*, and to change with the finger (without sending currents to station *III.*) the signal "blocked" to "clear." The block section between stations *II.* and *III.* still remain blocked; but, as soon as the express has passed station *I.*, this station, by blocking itself, electrically unblocks station *II.*, and allows the shunted goods train to proceed towards station *I.*, when the usual electrical connection between the three stations is again established.

If it be necessary for trains entering a station to receive a permissive signal at the entrance block station from the platform, the arrangement is adopted as shown at Fig. 6, where two trains are awaiting the "clear" signals which are to be sent from the platform to the entrance block station. In this case there is a magneto-inductor at the platform, and the two block stations, *I.* and *II.*, at either end; the block apparatus is of the usual construction, but has, in addition, the transmitting key, T, which, when pressed down while the handle, H, is turned at the same time, causes an alarm bell, W, to ring at the station-platform, announcing the approach of a train. In order to answer the signal, the magneto-inductor at the platform is also provided with a transmitting key, S, the pressing down of which, while the handle, M, of the inductor is turned, clears the entrance block station, and allows the train to enter. As soon as the train has passed the entrance block station, the signal is again set to "blocked."

Should it be desired that the entering train be announced by a visible signal, as well as by the bell-signal, a block-signal apparatus is placed at the platform. In Fig. 7, which shows an arrangement for this purpose, the platform and both the entrance-instruments show "blocked." Let it be supposed that a train approaches the entrance block station *I.*, the signalman presses down the key, T, simultaneously turning the handle of his inductor, H, and thus rings a bell in the platform apparatus, thereby inquiring whether the down train may enter that station. If the platform is clear, a signal is sent back, ringing a bell at *I.*, and also changing the block signals at the entrance block station and at his own platform into "clear." As soon as the train has passed the entrance block station, *I.*, the signalman puts his standard signal at "danger," produces at his own apparatus the electric signal "line blocked," and at the same time clears the preceding station as usual, thus blocking his own again, and, as a proof for the station master that a train has passed the entrance block station, changing the "clear" signal into "blocked" at the station-master's instrument. Both signals are thus placed at "blocked" again, and remain so until another train approaches that entrance block station.

Fig. 8 shows an arrangement where the block signals begin at the platform of a terminus instead of at the entrance block station. In this case the entrance apparatus is connected with the season block apparatus by two line wires, the second wire leading to a key, T, at the entrance apparatus. All trains leaving the terminus are signalled as usual, and those entering are signalled as in the last case, an arrangement which gives the station-master entire control over the traffic. Block-signal apparatus may also be conveniently used as distant signals between platform and entrance block station, as shown at Fig. 9.

As the use of alternate magneto-electric currents for the production of the simultaneous audible and visible signals, "line clear" and "line blocked," is the important point as regards safety of Messrs. Siemens and Halske's block system, it may be mentioned incidentally that currents of this nature, uninfluenced by atmospheric electricity, are sent from one signal-box to another in a direction opposite to that in which the train is traveling; but it must not be forgotten that there is an accessory part of that block system which, whether working or not working, could not interfere with the safety, and which is actuated by the same induction machines which give the block signals, though independently. Experience has shown it to be useful to warn signalmen when a train has left the preceding block station and is traveling towards them. This information, though produced by the turning of the same induction-coil handle as that for blocking and unblocking the signals, is obtained by the lowering of a separate key, and its working might possibly be interfered with by strong atmospheric currents.

The arrangement for sending warning signals in a forward direction is shown at Fig. 10. P^1 and P^2 are the plungers or contact makers, the depression of which cuts either the up or the down index out of circuit and brings the line wire of either side into direct communication with the magneto-inductor. The latter is so constructed that, of the two currents produced at each revolution of the coil, only one is permitted to enter the line to obtain this result. The spindle of the revolving coil is for a short distance cut in half, one half being taken away and replaced by a piece of insulating material. One contact spring, *x*, is in communication with either terminal, p^1 or p^2, and receives the current produced during half the revolutions of the coil: that is, when the spring, *x*, bears against the metallic part of the spindle. The contact spring, *x*, is, however, in constant metallic contact with either line *via* the springs, s^1 or s^2, when the plungers, T^1 or T^2, are pressed down. The latter contact spring, *x*, therefore, communicates both currents to either line. The currents of like kind passing by the spring, *x*, cause a bell to sound at the forward block station, thereby warning the signalman of the approach of a train. By pressing down the plunger, P^1, these currents pass from the magneto-inductor into the up-line, L^1, and, by pressing down P^2, into the down-line, L^2. The course of the single currents being from earth through the magneto-inductor, *x*, p^1, P^1, L^1, to the forward stations into P^2, M^2, s^1, W^2, through coils of up-bell, W^2, through bobbin of down-line index to earth, the index will not be affected, but the bell will give any number of vibrations corresponding to the manipulation of the magneto-inductor.

As railway telegraph posts are, as a rule, already overloaded with wires, it is a matter of importance not to still further increase their burden; and in this respect, again, Messrs. Siemens & Halske's compares favorably with other systems, as the whole of the block signals for a double line, together with those for giving the intimation that a train has left the preceding block station, are worked by means of a single wire.—*Iron.*

LOCOMOTIVE WIPING.

THE General Manager of the Philadelphia and Reading Railroad advocates an abandonment of the practice of wiping locomotives. The manager states that he commenced the experiment three months since by dispensing with 150 wipers and ceasing to purchase waste; and he finds that after the company's engines have run an aggregate distance of 2,250,000 miles, his locomotive stock is "in quite as good working condition as it possibly could have been had it been subjected to the most pains-taking rubbing and polishing." The manager estimates that by dispensing with wiping he is saving $235 per day.

FOUR or five dredging machines now suffice to keep the bed of the Suez Canal clear of sand to the required depth.

MACHINERY FOR LACE-MAKING.

VERY few but those engaged in the lace manufacture may have any idea of the costly nature of the machinery employed and the amount of capital embarked in the enterprise. It is no unusual circumstance for machines built in late years to cost very little below £1,000 by the time they are got to work and the first inch of lace is made from them. To have cost £500 or £600 is quite a common occurrence. The majority are capable of making lace four or five yards in width, and there are machines in the trade capable of making lace seven yards wide. They are driven by steam power, and stand in factories built specially strong to sustain the immense weight put on each floor. Some of these factories are magnificent buildings, the rooms ranging from twelve to fourteen feet in height, and the space across the rooms, from window to window, thirty-two feet and more. The windows are made as large as possible, as the best light is needed to carry on the manufacture. The custom is for the owners to let off standings for the trade, for which from five and sixpence to seven shillings per week each is charged, the owners also providing steam power. Each standing extends from window to window, the breadth being from six and a half feet to seven feet. It may give some idea of the depression in the trade when in rooms holding ten or a dozen of these costly machines it has been no rarity lately to see them all, with the exception of one or two, totally idle. The charge for standing room and steam power has to be paid for all the same, whether the machines be at work or not. The number of operatives thrown out of work by this state of things is greater than at first sight would appear to those not acquainted with the custom of the trade. During a normal state of trade the engine starts at four o'clock in the morning, and runs on till midnight, a day of twenty hours long, two sets of hands being employed. The first set go on at four o'clock in the morning, and work till nine, when they are relieved by the second set, who work till one. The first set then again appear, and work till six, when the second set once more come on, and work till midnight. The next week the men change shifts, those that began at nine o'clock the previous week then beginning at four. By this mode the men work ten hours a day each, except on Saturday, when the engine stops at one o'clock. It will thus be perceived that every machine brought to a standstill represents two operatives thrown out of employment. Until fashions take a decided turn in favor of lace, manufacturers cannot expect any permanent improvement in the trade.—*Inventor.*

A NEW USE FOR PAPIER MACHE.

THE customary preliminary trial, before applying any new composition for the prevention of the growth of weed or barnacle on the bottoms of our iron ships, has been made at Portsmouth dockyard, of an invention by Captain Frederick Warren, R. A., whose name is associated with a number of ingenious devices for leak-stopping and other purposes. The invention was tested upon an iron plate which was immersed in the harbor six months ago, and from the clean condition which it presented when lifted, a few days since, there can be little doubt that the application will prove of service. The method is at once simple and cheap, and differs from nearly every other which has hitherto been tried. To prevent fouling, the hulls of ships below the water-line are usually painted or coated with composition or cement. The preparations for the purpose are exceedingly numerous, and their merits are found to be so nearly alike that in the absence of unquestionable superiority on the part of any, the Admiralty are giving all a turn, the ship sometimes having as many as three kinds of anti-fouling compositions on the bottom. Captain Warren's invention, however, is neither a paint nor a cement; neither can it be said to possess any exfoliating property, the virtue on which all paints hitherto used have depended for their success. The treatment which he proposes to apply to the hulls of iron ships is not unlike the sheathing which is applied to wooden ships, only, instead of copper sheathing, he proposes to apply sheets of paper or thin strips of *papier mache*. He has discovered, by a series of practical tests, that, however long paper may be sunk in water, neither grass nor low forms of animal life become attached to it, not because the material exfoliates, and consequently throws off the accretions, but because there is something in the pulp itself which is inimical to growth of any kind. The plate to which allusion has been made was first of all covered with a coat of new marine cement, of which Captain Warren is also the inventor, the peculiarities of which are that it is applied cold, that it hardens under water, and that it possesses great holding powers. The cement answers the double purpose of protecting the iron and of acting as an adhesion for the paper which is afterwards placed upon it. In the preliminary test, sheets of common brown paper were used, and when examined after six months' immersion they were found to be perfectly free alike from any vestige of grass or signs of barnacles. The plate was also clean as regards oxidation except around the edges, which had not been subjected to the treatment. The reverse of the plate, which had not been coated with any preparation, was covered with rust and shellfish, and so confirmed the success of the experiment. The success was certainly such as to justify an immediate trial on a large scale and under more practical conditions. The cement, besides acting in the manner described, has the additional merit of standing a much higher temperature than pitch, which is now used, without melting in the seams, and may therefore be of use in coating the decks and top-sides of vessels in tropical climates.—*Ryland's Iron Trade Circular.*

BENT GLASS.

THE *Cincinnati Commercial* says: "In the front of Mr. Sinton's new building on Fourth street, near Central avenue, are bent glass show-windows, which, because of their novelty in this city, attract a good deal of attention. Bent glass plates are not in common use, except for inside show cases, and now and then in the fronts of some of the costliest hack carriages. The process of bending the plates is rather a delicate one; only the best French glass will successfully submit to the operation. Edward Edgeley, in the employ of Crane, Breed & Co., was employed to bend the glass for Mr. Sinton's building. A peculiar oven was constructed In this was placed an iron plate or form, of the shape of the desired glass. On the iron was laid the glass, and the oven was carefully heated with charcoal to a high degree, until the flat plate of glass became pliable and drooped of its own weight over the iron form. Then the door of the oven was sealed up tight with fire clay, to prevent any air-draught, and the oven left for three or four days, until the whole had slowly and thoroughly cooled. The effect of show-windows with the corners curved is rather pleasing.

SAVILLE'S PATENT GAS SCRUBBER-WASHER.

THE simplicity and efficiency of apparatus employed for the purification of gas is a paramount problem in its manufacture. Every manager of a gas-work, especially in the "full make" season, when all his apparatus is taxed up to its greatest capacity, is as anxious for the quality as he is for the quantity of the gas produced, being fully aware that public observation and the "inspector's report" deal mainly with the former of these considerations. It is comparatively easy to increase the quantity when a brisk demand occurs, such as is usually experienced in midwinter, by "driving" the retorts; but, in proportion as this is done, the whole purifying plant (especially where lime or oxide is the only means of purification employed), becomes a source of increased anxiety, labor, and cost, and, in most neighborhoods, a most frequent nuisance. Although lime and oxide have been the prolific means employed for this purpose, it has long been felt that much greater economy may be effected, and much abatement of the nuisance of changing large open boxes charged with "loud odors" may be attained, by the extended use of water, either in washers where the gas is caused to pass through water, or in scrubbers where a large area of damp surface is obtained by the mechanical distribution of a minimum quantity of water, so that the gas, passing over such surface, may precipitate more or less of its impurities.

At a recent meeting of the British Association of Gas Managers, held in the rooms of the Society of Arts, the President (Robert Morton, Esq.), in delivering his Inaugural Address, made the following remarks:

"A 'Washer,' by Mr. G. E. Saville, of Sowerby Bridge, Eng., a diagram of which is exhibited on the wall, and by which the gas is brought into very intimate contact with the water, and that without much increase of pressure. A vessel, 8 feet square, with the working part only 20 inches high, gives 1,600 lineal feet of dip, 830 superficial feet of wetted surface, and 250 square feet of water area, throwing about 1½-inch pressure. I am told that gas free from ammonia, and containing comparatively little CO_2, is obtained by its use, while the water used escapes as very strong liquor, 20-ounce to 30-ounce."

At the same meeting Mr. Charles Hunt, of Birmingham, read a paper on "Washers or Scrubbers," in which the following statement appears:

"So far as I am aware, washers have not, hitherto, been employed to any extent for the final process of removing the last traces of ammonia, although there seems to be no reason why they should not, and a few weeks ago I had an opportunity of inspecting a new form of washer, designed by Mr. Saville, of Sowerby Bridge, alluded to by the President in his opening address, which has proved efficient for this purpose."

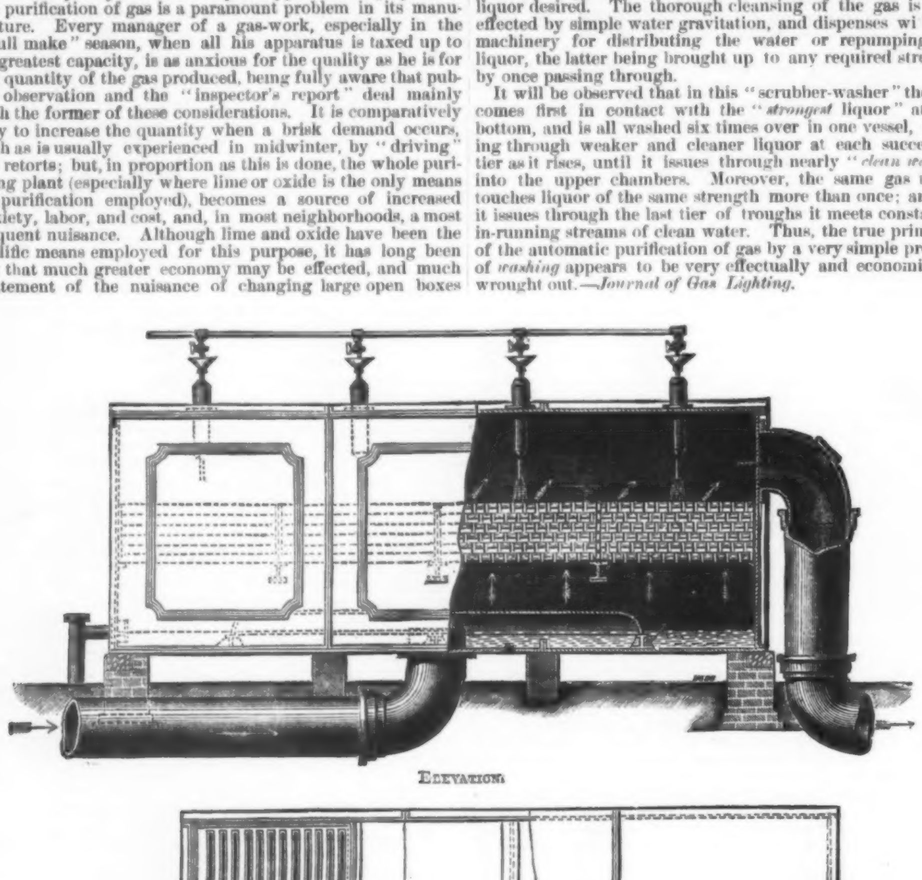
The results of analyses give a high duty, although taken from the first of Mr. Saville's washers, fitted with wooden troughs for experimental purposes, passing half a million feet per day.

The above illustration is a scale representation of a washer 16 feet by 8 feet, by only 4 feet high, capable of washing 3 million cubic feet per day.

The mechanical arrangement is thus described: The washer tank contains a large bottom chamber, into which the gas is freely admitted through an ordinary full-way inlet-pipe, passing first under an inverted vessel, to remove the tar remaining in the gas after leaving the condenser; it then rises slowly over the whole surface, containing an area of openings equal to about eight times that of the inlet-pipe, through equidistant spaces and through a series of slightly self-sealing water troughs arranged in tiers, thus dividing itself into 930 streams of gas, each of which is passed through cleaner liquor at each tier as it rises, until it ultimately issues through nearly clean water into the large upper chamber, and from thence through the outlet main-pipe.

The washing liquid, being *clean water*, enters into the tank through the syphon inlets on the top, each having a regulating-cock to equalize the supply to each square of troughs, and these are controlled by one main-cock, so that the quantity of water admitted may be exactly proportioned to the quantity of gas to be cleansed and the strength of ammoniacal liquor desired. The thorough cleansing of the gas is thus effected by simple water gravitation, and dispenses wi h all machinery for distributing the water or repumping the liquor, the latter being brought up to any required strength by once passing through.

It will be observed that in this "scrubber-washer" the gas comes first in contact with the "*strongest* liquor" at the bottom, and is all washed six times over in one vessel, passing through weaker and cleaner liquor at each successive tier as it rises, until it issues through nearly "*clean water*" into the upper chambers. Moreover, the same gas never touches liquor of the same strength more than once; and as it issues through the last tier of troughs it meets constantly in-running streams of clean water. Thus, the true principle of the automatic purification of gas by a very simple process of *washing* appears to be very effectually and economically wrought out.—*Journal of Gas Lighting.*



SAVILLE'S PATENT GAS SCRUBBER-WASHER

MECHANICAL PROGRESS IN FRANCE.

WE give some details regarding the progress made in the industrial arts in France, taken from a census recently made of the working and material development.

From this it appears that the total machine force of the country is at present 1,500,000 horse power, representing a force of 4,200,000 draft horses, or 31,500,000 men—that is to say, ten times the valid industrial population of France. This substitution of machine-work for hand-work has produced an economical revolution in French industry, which it is interesting to compare with the industrial state of France in 1788 before the introduction of machines. The first steam engine that appeared in France was set going in 1789. It came from the manufactory of Boulton & Watt, at Birmingham, and was used for the water supply of Paris. Unfortunately, from the great Revolution to 1815 machinery industry in France almost disappeared, and it was not until 1824 that the French began to manufacture steam engines, and many of their manufactories now rival those of England. In 1852 France possessed only 6,000 steam engines, representing a force of 75,000 horses. In 1862 the number of engines had risen to 22,500, and the horse power to 618,000. From this year the increase was extraordinarily rapid, until, as stated above, the horse power of the steam engines in France attained 1,500,000 last year. In 1788, of one milliard of manufactured products 60 per cent. was workmanship and 40 per cent. raw materials. To-day the proportion is exactly the reverse; the workmanship is forty per cent. and the raw materials 60 per cent., and yet it must be remembered that workmanship has increased 40 per cent. during the past twenty years. To-day the annual production of France is about twelve milliards, of which the raw material is seven milliards, and the workmanship five milliards, whereas, in 1788 the workmanship would have cost eleven milliards. It results from this that the introduction of machine work has led to a saving of six milliards in the workmanship. Such figures speak for themselves.—*Coal Trade Journal.*

THE TURBINE TESTS AT THE CENTENNIAL.

MANCHESTER, N. H., March 13, 1877.

To the Editor of the Scientific American:

I write to ask you to correct an error in the very admirable report of your correspondent, Mr. Hawkins, on the turbine tests at Philadelphia.

Mr. John Cotter, who has twice put in a claim to the supervision of the tests, or rather to the *credit of it*, was simply one of my assistants. He never saw a wheel tested till I taught him at the Centennial how to do it. He was a very kind, obliging, and faithful assistant, in putting the weights in the scale pan, and noting the revolutions as my son called them off, and I shall always entertain a high esteem and respect for him; but I must beg leave to say that the whole superintendence devolved on me, I having been invited by Col. Albert, the Chief of the Bureau of Machinery, to take charge of the tests, and appointed by the Direction a special judge in group 20 for that purpose.

I notice one or two very slight errors, viz., the temp. of the water was carefully and frequently noted, and held at 75° Fah., or 62·234 per cubic ft. up to Nov. 1, when it fell off to 70°, and was taken in the last 3 tests at 62·3 as your correspondent has it; but I must give him the credit of very great general accuracy, and a clear comprehension of the whole matter. A slight typographical error makes the friction pulley, in the case of the Tyler wheel, to have been *down* on the upper bearing, whereas it was up above it 16 inches, causing vibration, from the fact that the shaft was *longer* and not *larger*, as printed.

I believe the results as printed to be very valuable, and to show a very close record of the actual results which may be expected from turbines in practical use, as in contradistinction to the inflated tests which are published by men who are simply advertising. Trusting that you will make the necessary correction, and give me the credit which simply belongs to me, I remain, yours very truly,

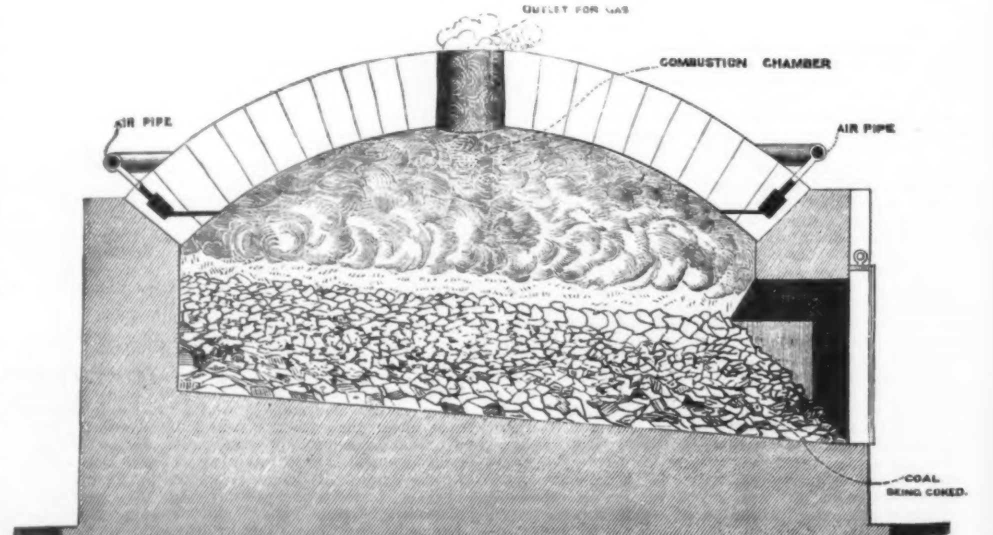
SAMUEL WEBBER.

IRON FREIGHT CARS.

The *Iron Age*, in describing the iron freight cars now building in Boston, Mass., and McKeesport, Pa., says that the freight cars (platform and box) are made out of wrought iron tubes and steel rods. A platform car carrying stone and a box car carrying ice have been running more than eighteen months without a dollar's worth of repairs. The loads they carry are limited only by the strength of the trucks and springs. The common load of the stone car is more than fifteen tons, and that of the ice car, which has nineteen hundred cubic feet of freight space, has been twenty tons. The saving of dead weight in these cars is as follows: The wooden cars in the train carrying stone weigh 11,560 pounds, and the iron car 5,214 pounds; the wooden ice cars weigh 16,400 pounds, and the iron car 8,420 pounds. The platforms were tested by piling ten tons of railroad iron crosswise in the center of the car on the smallest base possible, and the deflection was only three-eighths of an inch, which disappeared as soon as the load was removed.

AITKEN'S COKING OVEN.

THIS improvement is especially designed for the economical production of coke, and the results of its practical use show a remarkable economy over the ordinary ovens. It is adapted both to the cold and the hot blast. It effects a saving in the time of the cooking operation, and increases the yield of coke. The improvement is in practical use in England with great success, saving from 20 to 25 per cent. in coke, and 18 hours' time on each change. George Watson, C. E., 36 Great George street, Westminster, London, will give further information.



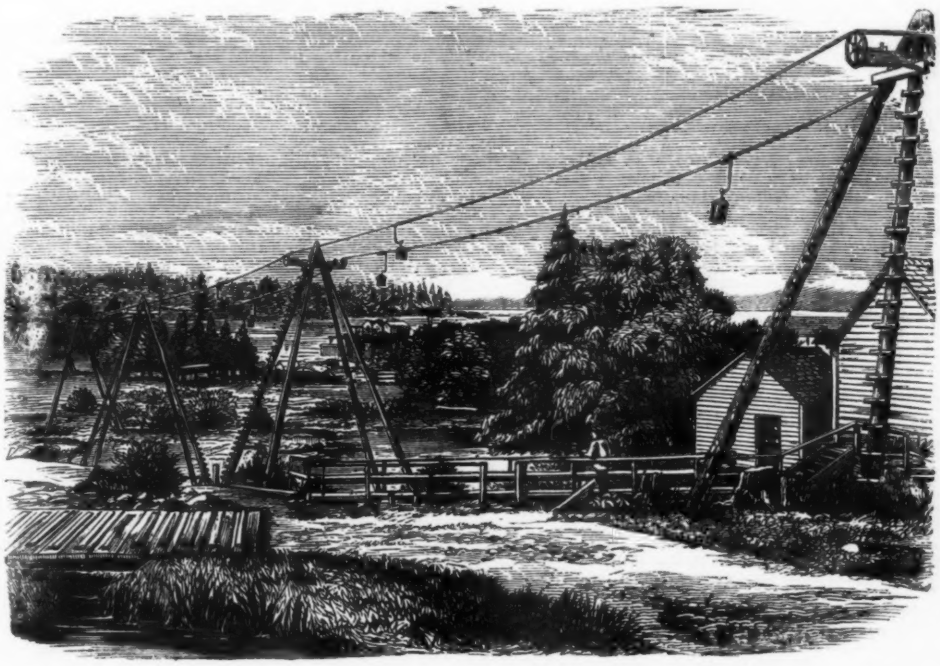
AITKEN'S IMPROVED COKING OVEN.

WIRE RAILWAY.

WE annex an engraving representing a wire tramway lately erected at the Harewood coal mine at Nanaimo, British Columbia, for the purpose of carrying the coal down to the shipping port, a distance of about 3¼ miles. The mines are situated at a considerable elevation above the sea level, and the intermediate ground is covered with trees and rocks, while several deep ravines intercept the line of tramway. Under such circumstances the construction of a railway would be costly and tedious, as it would entail the erection of several viaducts and the adoption of a circuitous route; the proprietor of the mines, therefore, decided on putting up a wire tramway in a direct line from the mine to the port by means of which the ravines could be spanned without expense, and the timber on the ground could be converted into the necessary posts.

There are in all ninety-seven posts, varying in height from 15 ft. to 80 ft., the distance between them varying from 150 ft. to 250 ft. The wire rope is of the best crucible steel, specially made for the purpose, and is 6½ miles in length; it is carried on each post by means of a pair of grooved pulleys 2 ft. in diameter. The rope is driven at the lower end by means of one of Robey's semi-fixed engines, of 20 horse-power, which is found to be of ample power to drive the line when carrying 12 tons per hour.

The driving machinery is fitted with drums 10 ft. in diameter, which, for convenience in shipping, were all made in segments. At the mine the rope simply passes round a 10-ft. drum. There are 250 iron buckets, each carrying 2 cwt. of coal, and each one fitted with a patent hanger and boxhead, by means of which all jolting when passing over the supports is avoided. This tramway is capable of carrying 120 tons per day, and has been at work for about eight months, during which time it has worked without stoppage or accident. The machinery for it was made from the designs of Mr. Carrington, the engineer to the Wire Tramway Company, of Cheapside, London, for the proprietor of the mines, Mr. T. A. Bulkeley, of Nanaimo. Many other tramways have been recently put in operation in various parts of the world, as, for instance, in Mauritius, where they have been successfully applied to the carriage of sugar-cane; also in New Zealand, where they are used for carrying manganese ore; and elsewhere.—*Engineering.*



WIRE RAILWAY AT THE HAREWOOD COAL MINE, BRITISH COLUMBIA.

PURE RED ASH COAL.

THE *pure Red Ash Coal* veins are invariably found lying *above* the White Ash veins, and are of a later geological formation. They are not so dense, and are purer carbon than White Ash coals: they will produce less ashes of greater specific gravity, and will give out more heat; produce more steam and hold fire longer than White Ash coals: they burn with more flame and make an intense heat. Any one can verify the truth of these observations by consulting Prof. Johnston's report to the Navy Department—of trials made of various coals presented for steam and heating purposes. His experiments were made scientifically and with much care.

Consumers of coal should bear these facts in mind, because economy consists in using coal which produces the best effects, while it requires less draft for consumption, lasts longer, and requires less quantity to make fire. It will also hold fire longer. These properties make it a favorite coal among householders living in tenement houses, where the chimneys being used by so many families impair the draft, and being under the personal control of the *wife*, more economy is the result; hence, with this class, these facts are apparent, and they call for a *pure* Red Ash Coal. All the pure Red Ash coals are scarce and higher in price, costing more to produce them from their veins, subject to interruptions from faults, yet they are cleaner and cheaper to use than White Ash coals. The difference usually made is fifty cents per ton, while the actual gain is greater. These facts being patent, care should be taken to *ask* for and *demand* the best Schuylkill Red Ash coals, such as the "Gate Vein," "Diamond Vein," "Palmer Vein," "Black Mine," "Spohn and Lewis Veins." The old "Peach Orchard" vein was celebrated and became popular in its day, and it is even now called for, but has been out of the market for twenty years! This coal was tested by Prof. Johnston. The Primrose Vein, Peach Mountain and Orchard Veins are Pink Ash coals, and are inferior in quality. The Primrose Vein produces a good appearing coal, but is the poorest coal known of all the anthracites. The Buck Mountain Vein of coal lies next to the Conglomerate rock, and is from fourteen to twenty feet thick. Truly speaking, it is made up of two veins, but the parting state is so thin they cannot be worked separately. One half is hard Red Ash, and the other half is hard White Ash; burned together, it produces a fawn-colored ash, and makes a coal which, for general purposes, is not excelled. The Red Ash Coal gives flame and intensity of heat, while the White Ash coal gives it body, and prevents clinker. It is the best coal for generating steam known, makes less ash, lasts longer, and produces better results than any White Ash Coal alone. Any good Red Ash Coal mixed with White Ash Coal will produce better results. The Buck Mountain Coal is used on locomotives for generating steam with much success. It is tough, and will not snap and fly, injuring the copper tubing in the boiler. For use under stationary boilers, a coating of White Ash Coal, to commence the fire, and Red Ash Coal sprinkled, *a little at a time* over it produces quick steam, and is more economical than White Ash Coal alone. Too much coal over the grate bars is a positive waste. Waste steam, blown off *under* the grate bars (with closed doors to the ash pan) produces astonishing results, cleaning and producing a livelier fire. If all engines were arranged to exhaust under the grate box, much economy would be produced thereby. A water pan under the grate bars, at the bottom of the ash pan, is useful also; and, if the reader will put in practice these suggestions, their adaptability will become apparent. It is a fact that but few engineers understand how to burn coal so as to get the best results. It is the greatest amount of caloric produced with the least waste of heat up the chimney in the consumption of coal which is the desideratum, for draft made by the application of waste steam, under the grate bars is equal to as much coal as will produce the degree of heat in the exhaust steam. It is strange that the philosophic utility of single organic laws are not more generally diffused among engineers and firemen. On locomotive engines, when the engineer desires a quick fire, steam is turned on *under* the bars, producing the results demonstrated. A word to the wise is sufficient.—*Coal Trade Journal.*

CHEMISTRY AND MINERALOGY.

Paraldol.—Wurtz (*Compt. Rend.*, lxxxiii. 255) finds that aldol, when left to itself for some weeks, deposits colorless crystals which gradually increase till they occupy the whole space previously filled with the liquid. The new polymeric modification formed in this way is purified from any still liquid aldol by means of ether, in which it is less soluble. The polymer holds the same relation towards aldol as paraldehyde to aldehyde. When distilled *in vacuo* it passes over between 90° and 100° C., and forms a crystalline distillate. It is easily soluble in water and alcohol, and separates from the latter menstruum in fine crystals. When dissolved in ether the new substance appears to be partly changed again into aldol. It abstracts oxygen from other bodies with great energy: an aqueous solution in presence of silver oxide forms β-oxybutyric acid. Paraldol crystallizes in the oblique prismatic system.

Nicotine.—Kirchmann recommends a method for the ready preparation of this alkaloid in a state of purity (*Archiv. Pharm.* [3] ix. 209). He fills a brass vessel, provided with two conducting tubes, with tobacco moistened with sodium carbonate, and heats the apparatus in a steam-bath while a current of carbonic acid traverses the vessel; the gas, on emerging, is conducted through a mixture of alcohol and dilute sulphuric acid. In this way a considerable quantity of nearly colorless nicotine is obtained in the form of sulphate, which can then be decomposed with baryta. After alumina had been dissolved in some of the acid liquid just referred to, the solution yielded on evaporation fine octahedra of what the author states to have been nicotine alum.

Native Iron.—The presence of iron, as iron, in basalts and dolerites, has hitherto been recognized by Andrews, Reuss and others, in an indirect way only, by treating the magnetic portion of the rock with copper sulphate, when the metal of the salt changes place with the iron, and is recognized by its color and lustre. Hawes, in the January number of the *Amer. Jour. Sc.* xiii. 32, describes his examination of the olivinous dolerite of Dry River, New Hampshire, in which he has been able to recognize with the eye the presence of this metal. These dolerites are composed of labradorite, pyroxene, olivine, and magnetite, with a little mica; and, although they contain somewhat alterable materials, the rocks are remarkably fresh, and all the minerals are clearly to be distinguished in a microscopic section. The test with copper sulphate was first resorted to, and numerous bright crystalline aggregations of copper were plainly distinguishable. The sections were then more closely examined under a high power, and it was found, when reflected light was employed, that the bluish-black fragments of magnetite, inclosed in the rock, surrounded others, which had the bright metallic lustre of iron. A section presenting this appearance was treated with sulphate, and the central grain was found to be covered with a coating of copper. The author gives in his paper a woodcut of a section showing the constituent minerals, and the position of the metallic core. He alludes to the fact that the presence of metallic iron in basalts has been supposed to be due to the agency of carbon or some other reducing agent which, acting on the magnetite at a high temperature, had reduced a portion of it to metal. The presence of this iron in the centres of the irregular grains of magnetite seems to indicate the possibility that the magnetite itself may be a product of the oxidation of the iron. Trautschold, of Moscow, describes in the *Jahrbuch für Mineralogie*, 1876, 635, a curious fragment of native iron found in the gold-bearing alluvium at the Gunzburg gold-washings, near Nachtuisk, in Jakutsk, Siberia.

The Explosive Characters of Mixtures of Marsh Gas and Air.—Coquillion has examined the conditions under which mixtures of marsh gas and air can be fired (*Compt. Rend.*, lxxxiii. 709). A mixture of one volume of the gas with seven to nine of air is not exploded by a red-hot iron rod or a white-hot platinum spiral; when exposed to a flame it ignites with a scarcely audible explosion. The author found in the electric spark a more certain means for arriving at the limits within which mixtures explode than the flame of a taper, which Davy used, and conducted his experiments in a eudiometer. He observed that under these circumstances one volume of marsh gas with five of air does not take fire, but that one volume with six explodes feebly; when seven, eight, and nine volumes of air were employed a slight detonation was remarked, although when ignited with a flame they burnt quietly; with twelve, thirteen, fourteen, and fifteen volumes of air explosions still occurred; and when sixteen measures of air were introduced a change was scarcely perceptible. The limits, therefore, are six and sixteen volumes. The author placed a mixture of two volumes of oxygen and one of marsh gas in a eudiometer provided with a palladium wire, which he rendered incandescent with a voltaic current; the mixture did not explode but rapidly decreased in volume. The gases mixed in the same proportion and exposed to the flame of a candle detonate with great violence.

The Solubility of Gases in Iron.—Researches on this subject, conducted by L. Troost and Hautefeuille, and extended over several years, have led to the following results (*Ann. Chim. Phys.* [5], vii. 155). When cast iron is melted in contact with silica and silicates, carbonic oxide is given off by the action of the oxygen of the silica on the carbon of the iron; while the percentage of the carbon present in the iron is diminished that of the silicium is increased. Molten iron dissolves considerable quantities of hydrogen; the presence of silicium weakens its power to absorb the gas, but the presence of manganese increases it. Carbonic oxide is far less abundantly taken up by the varieties of manufactured iron than hydrogen is. Manganese, when present, lessens their power in this respect, and may destroy it altogether. The gases retained by the iron can be expelled by heating it to temperature below 800°; when greater heat is applied they react on the metal. Hydrogen is more abundantly retained both by molten and solid iron than carbonic oxide is, and is occluded more firmly than the latter; cast iron containing manganese dissolves more hydrogen than ordinary varieties of the metal. Steel takes up less gas than cast iron; here, again, hydrogen is more abundantly and firmly retained than carbonic oxide. Wrought iron, on the other hand, occludes more carbonic oxide than hydrogen. The carbonic oxide dissolved in iron or steel can only be determined by dissolving the metal in mercury chloride at ordinary temperatures *in vacuo.*

The Molybdic Acid Reagent.—The change which takes place in a solution of ammonium molybdate in nitric acid after the liquid has been prepared some time has been studied by Jungk (*Zeitschr. anal. Chem.* xv. 290). This valuable reagent, so constantly in use for the detection of the presence of phosphoric acid, is known in process of time to become turbid and to deposit on the sides and bottom of the vessel in which it is preserved a yellow precipitate which closely resembles the body which it forms with phosphoric acid or silicic acid. The author examined a large quantity of the yellow substance and found it to contain neither of these acids. It appears to be a modification of molybdic acid, produced by the action of light on the reagent. When the latter is preserved in the dark it remains clear for weeks together, but by exposure to sunlight for a few hours it becomes very turbid. Molybdic acid resembles in this respect some of the compounds of uranium.

Chromium Arsenite.—This compound has been prepared by R. H. C. Nevile (*Chemical News*, 1876, xxxiv. 220) in the following way: A hot and strong solution of pure chromic acid is poured into a hot and saturated solution of arsenious acid; the liquid in the first instance becomes green but remains transparent; if it be kept near the boiling point it gradually becomes opaque by reflected light, but is still transparent in transmitted light. After a time a dark green powder separates, and this, on analysis, was found to have a composition corresponding with the formula $Cr\,As\,O_3$. This is less basic than the ferric arsenites which have hitherto been prepared.

Copper Sulphate.—Magnier draws attention to a peculiarity exhibited by the hydrated form of this salt (*Ber. Deut. Chem. Gesell. Berlin*, 1876, ix. 1932). Berzelius has shown that $Cu\,SO_4 + 5H_2O$ loses two molecules of water when placed over sulphuric acid at temperature between 25° and 30° C. The hydrate thus formed, $Cu\,SO_4 + 3H_2O$, can then be preserved in the open air at the above temperature without undergoing any further change. Magnier now finds that when the normal salt is dried *in vacuo*, at 25° to 30° C., it evolves four molecules of water.

Ihleite.—Schrauf has given this name to a new mineral species which occurs as a yellow efflorescence on graphite in the graphite deposits of Mugrau. It is a hydrated ferric sulphate, possessing the composition $Fe_2O_3,\ 3SO_3 + 12H_2O$ (*Wein. Anz.*, 1876, 50).

Adulteration of Beeswax.—According to Hell (*Pharm. Central.* xvii. 329), a new branch of industry has for its object the imitation of beeswax. A specimen of what was

supposed to be wax was found by him to consist of a mixture of 60 per cent. of paraffin and 40 per cent. of yellow pine resin, cast into the accustomed form and coated over with a thin layer of the genuine material. It appears, from the *Industrie-Blatt*, 1876, 35, that a number of Berlin "Apotheker wie auch Droguisten" have fallen a prey to the enterprise; and it is pointed out by the above journal that they can readily determine for themselves whether the supposed wax is spurious or not. Beeswax has a specific gravity of 0·960—0·963, and will float in the *Liq. Ammon. Caust.* of the Pharmacopœia, while resinous preparations, like those mentioned, will sink to the bottom.

THE German Chemical Society in Berlin have elected Prof. Wöhler president of the Society for the current year. This learned body, now entering on the tenth year of its existence, has met with the greatest success. It numbers 1,598 members, and the *Berichte* for 1876 covered 2,000 pages.

DR. TSCHERMAK, the Director of the Imperial Mineralogical Collection, and Professor of Mineralogy in the University of Vienna, has received a call from the Prussian Government to fill a Professor's Chair at Göttingen. The *Allgemeine Zeitung* states, however, that an endeavor is being made on the part of the Austrian Government to retain his services, and to induce him to remain on the staff of the University of Vienna.

DR. GROTH, Professor of Mineralogy in the University of Strassburg, is to edit a new journal, *Die Zeitschrift für Krystallographie und Mineralogie*, published by Englemann, of Leipzig. He has secured the co-operation of a number of crystallographers and mineralogists for the work. Unfortunately, French scientific men take no share in the new venture.—*Academy.*

ALKALIMETRY.

By J. CHISHOLM.

[Lately read before the Photo. Section, Amer. Institute.]

PREPARATION OF THE STANDARD ACID.

ORDINARY sulphuric acid, 1 fluid ounce diluted with 7 fluid ounces of water, and the mixture allowed to cool. Weigh 1 gramme of anhydrous carbonate of soda and dissolve it in about 10 to 15 cubic centimeters of water. Pour the diluted acid into the burette up to zero, and let it drop into the solution of carbonate of soda, to which a litmus solution has been added. Let the acid in the burette drop carefully into a boiling flask containing the carbonate of soda solution till the color turns red; now boil the flask to expel the carbonic acid. The process is finished if, after boiling, the red color remains.

In our example we found that 6·4 cubic centimeters by the burette were used to neutralize the carbonate of soda, and we wish to form a solution such that 10 cubic centimeters would neutralize 1 gramme of carbonate of soda. We have, therefore, the following proportion:

Acid.	*Water.*		*Acid.*	*Water*		*Acid.*	*Water.*
10—6·4=3·6		.·.	6·4	: 3·6	: :	200	: 112½

Equal the amount of water required to make a standard acid solution.

TO TEST COMMERCIAL CARBONATE OF SODA.

One gramme by weight is treated as above described; and, of course, the less acid used, the more impurities in the carbonate of soda on trial.

For example, if we use only 5 c.c. of the acid to neutralize 1 gramme of commercial carbonate of soda, it would follow that only one half or 50 per cent. of carbonate of soda is contained in the commercial article, while the rest is impurities. If, for instance, we used 9·1 c.c. of the acid, it would follow that the article on trial contained 91 per cent. of carbonate of soda.

In order to compare the strength of commercial ammonia with the carbonate of soda, we took for our example 10 c.c. of liquid ammonia and used 41·5 c.c. of the acid until the blue litmus turned red. Hence, it follows that 10 c.c. of the normal acid would neutralize 2·4 c.c. of ammonia; and as 10 c.c. of the acid also neutralizes 1 gramme of carbonate of soda, it follows that 2·4 c.c. of ammonia is equivalent to 1 gramme of carbonate of soda.

	Acid.		*c.c.* NH_3.		*c.c.* *Acid.*		*c.c.* NH_3.
As	41·5	:	10	: :	10	:	2·4

Therefore, 2·4 c.c. of liquid ammonia would be equivalent to 1 gramme dry carbonate of soda.

In another experiment made with commercial carbonate of ammonia 1 gramme required 11 c.c. of normal acid to neutralize it. Therefore 0·91 gramme would be equivalent to 1 gramme of carbonate of soda, or 2·4 c.c. of liquid ammonia, all of which will neutralize 10 c.c. of the normal acid.

To simplify the above proportion between the carbonate of ammonia and liquid ammonia, we demand how much liquid ammonia is equivalent to 1 gramme of carbonate of ammonia?

grm. NH_4O,CO_2		*c.c.* NH_3	*grm.* NH_4O,CO_2		*c.c.* NH_3
0·91	.	2·4	1	:	2·6

Therefore, 1 gramme of carbonate ammonia is equivalent to 2·6 c.c. of liquid ammonia.

How much carbonate of potassa is equivalent to 1 gramme of carbonate of soda?

	NaO,CO_2		KO,CO_2		*grm.* NaO,CO_2		*grm.* KO,CO_2
As	53	:	69	: :	1	:	1·032

Therefore, 1·3 gramme KO,CO_2 will be indicated by the same quantity of normal acid as 1 gramme of carbonate of soda.

How much caustic potassa is equivalent to 1 gramme of carbonate of soda?

	NaO,CO_2		KO		*grm.* NaO,CO_2		KO
As	53	:	47	: :	1	:	0·87

How much caustic ammonia is equivalent to 1 gramme of carbonate of soda?

	NaN,CO_2		NH_3		*grm.* NaO,CO_2		NH_3
As	52	:	17	: :	1	:	0·32

That is to say, 0·32 NH_3 will neutralize as much normal acid as 1 gramme of NaO,CO_2; but the commercial ammonia contains a great deal of *water* which you can determine by the specific gravity of the liquor.

CARBONATE OF SODA DEVELOPER.

Mr. H. J. Newton, at a recent meeting of the Photo. Section of the Amer. Institute, said: I make a solution of two ounces of the soda in sixteen ounces of water, adding forty grains of bromide of ammonia. This solution will keep indefinitely, and in this respect, if no other, is superior to the carbonate of ammonia. Do not attempt to substitute the bicarbonate of soda, as it is a very poor developer unless first heated to redness, by which process one atom of carbon is driven off; then it will work the same as the other. This is, however, an unnecessary trouble, as the commercial article sold under the name of sal soda is pure enough for the purpose. When you wish to develop a number of plates, make a strong aqueous solution of pyrogallic acid; say fifteen or twenty grains to half an ounce of water; then pour into a wide-mouthed vial sufficient of the soda solution to cover the plate well; and, after washing the plate, put twenty or thirty drops of the pyro. solution into the soda solution and flow the plate. The image will come out and the development go on the same as a bath plate, under the action of the iron developer. I make my pyro. solution in a low wide-mouthed vial, and use a dropping tube to take it out. This tube has a rubber bag on the upper end; and, by pressing out the air and then removing the finger, it fills with the fluid, which is discharged into the vial containing the soda by pressing the bag at the upper end. This I let stand in the vial continually, and is therefore always ready. Do not use the pyro. solution after it is twelve hours old. I advise an aqueous solution, because I have never succeeded in developing with an alcoholic solution of pyro. to my satisfaction, or in getting results which would compare with those developed with the pyro. in water.

The energy of this developer can be greatly increased by using in conjunction with it a solution of ammonia in water, made and used as follows:

Water	½	ounce.
Ammonia, conc.	½	"
Bromide of ammonia	20	grains.

When ready to develop, add of this solution from three to twelve drops, according to the size of the plate; add this to the soda immediately before adding the pyro. and proceed as before. With this compound developer the exposure should not be more than one half or two thirds that required for the soda alone. It is much the most vigorous alkaline developer I have ever used. If your emulsion works thin, or gives a negative lacking intensity, it will gain greatly in intensity by the addition of the ammonia solution.

Mr. T. C. Roche exhibited a number of plates, in the development of which, he said, there was no alkali used. They were transparencies. Some of the most delicate lines that can be made are shown here. They are carbon pictures, made by Lambert's process. It is the simplest process he had ever worked. There is no silver in the pictures. The finest tones desired can be had by this method. He placed the pictures in boiling water for four hours, and they were not affected in the least.

He next showed some pictures made in imitation of Mr. Newton's Collodia-chloride. They can be printed by any one unacquainted with ordinary photography. These were printed by a little girl. Before the silver paper fairly begins to print, these pictures are made.—*Anthony's Photo. Bulletin.*

DEUTSCHE CHEMISCHE GESELLSCHAFT, BERLIN, JANUARY, 1877.

Prof. A. W. HOFMANN, F.R.S., Vice-President, in the chair.

AT the opening of the session, the presiding officer paid a brief tribute to the memory of the late Prof. J. C. Poggendorf, the editor of the well-known *Annalen der Physik und Chemie*, who died in Berlin, January 24th.

A. Pinner read a communication from V. Meyer "On Cuminol," in which it was stated that if perfectly pure it did not yield cymen upon treatment with caustic potash, as given in Kraut's investigations upon the subject. The latter's researches were probably made with cuminol which had not been entirely freed from cymen.

R. Münke exhibited a new rotatory aspirator, in which the necessity of changing the connecting tubes by each inversion was obviated; and some improvements in the methods for heating the air and gas supplied to a blast lamp.

C. Cech and P. Schwebel described "A Peculiar Formation of Iso-cyano-benzene." Dichlor-acetate of aniline upon treatment with caustic soda is changed almost entirely into iso-cyano-benzene and formic acid—

$$Cl_2HC—COOH.C_6H_5NH_2=CNC_6H_5+{}_2HCl+CH_2O_2.$$

M. Klobukowski gave the results of experiments upon the method of E. Kopp, proposed a short time since, for the "Determination of the Halogens in Organic Compounds." The process consists in heating the mixture of the substance to be analyzed with ferric oxide in a narrow glass tube, the remainder of which is occupied by a spiral of fine iron wire and a layer of carbonate of sodium. It was found that by using a tube of Bohemian glass, 60 c.m. long and 5 to 6 m.m. in diameter, the combustion was ended in five to ten minutes, and that the easiest way of bringing the contents of the tube into water was to dip its lower end while still hot into a deep beaker containing a little cold water. The method is to be recommended on account of its rapidity and accuracy, as well as the ease of obtaining perfectly pure Fe_2O_3 for the purpose.

F. Tiemann and H. Herzfeld stated that by treatment of salicylic aldehyd with sodium acetate and acetic anhydride they had obtained "ortho-coumaric acid," $C_9H_8O_3$, in a manner analogous to the formation of para-coumaric acid from para-oxy-benzoid aldehyd. The acid is separated out in the form of the acetyl compound by solution in ether and treatment with carbonate of sodium. The melting point of coumaric acid obtained in this way as well as by the ordinary method, is found to be 195°, instead of 207° as given by Perkin.

S. Gabriel read a paper "On Meta-sulpho-cynate of Phenylen," $C_6H_4(SCN)_2$, which was obtained by the action of ICy on phenylen sulphhydrate in closed tubes. It crystallizes in short needles, melts at 54°, and is changed by nitric acid and sulphuric acid into nitro-sulpho-cyano-phenylen, $C_6H_3.NO_2.(SCN)_2$—yellow needles melting at 150°.

The same author also read a paper "On Ethers of the Tribasic (Ortho) Thio-formic Acid." Ortho-thio-phenylic formiate, $CH(SC_6H_5)_3$, is obtained by the action of chloroform upon sodium phenylic mercaptide, and ortho-thio-ethylic formiate, $CH(C_2H_5S)_3$, from the corresponding ethylic compound; the former crytallizes in thick prisms; the latter is a liquid, boiling under partial decomposition between 200° and 250°, and possessing a most offensive odor.

Prof. Hofmann stated that a triphenyl-guanidin was easily obtained by the action of carbon tetrachloride upon aniline in open flasks, without having recourse to the more complicated method given at the time of its discovery.

The same author described also some experiments on the composition and preparation of a new orange-coloring matter, called "chrysoidin," which has lately appeared in the market. Analysis proved this body to be the hydroclorate of diamido-azo-benzene, $C_{12}H_{12}N_4$, thus placing it midway between aniline yellow (mono-amido-azo-benzene) and phenylen brown (triamido-azo-benzene).

Aniline yellow,	$C_{12}H_9NH_2.N_2=C_{12}H_{11}N_3$.
Chrysoidin,	$C_{12}H_8(NH_2)_2N_2=C_{12}H_{12}N_4$.
Phenylen brown,	$C_{12}H_7(NH_2)_3N_2=C_{12}H_{13}N_5$.

Chrysoidin is easily obtained by submitting the diazo-benzene of P. Griess to the action of phenylen-diamin—

$$C_6H_4N_2+C_6H_8N_2=C_{12}H_{12}N_4.$$

The phenylen-diamin to be used is the one yielded by reduction of dinitro-benzene. The isomeric compound prepared from aniline yields no coloring matter. A series of analogous coloring matters may be obtained by submitting the azo-fulminates of aromatic monamines to the action of diamines.

F. Tiemann and B. Mendelsohn read a paper "On the Components of the Creosote obtained from Beechwood Tar." The fraction of the acid oil of this creosote boiling at 220° consists chiefly of creosol and phlorol, and the relations of these two to other well-known compounds have been examined. Creosol has been changed first into an acetyl compound, and then by oxidation into vanillic acid, and receives, therefore, the structural formula $C_6H_3(CH_3)(OCH_3)(OH)$, the sidelinks in the order 1, 3, 4. Phlorol was changed first into methyl-phlorol, and this was oxydized to an oxyphthalic acid, identical with that obtained from salicylic acid. Phlorol is therefore to be regarded as an oxy-xylen, $C_6H_3(CH_3)_2(OH)$.

The following papers from non-resident members were read:

H. Wald, "On Para-dinitro-diphenyl." On treatment with sodium amalgam 2 molecules of this compound unite together, under separation of 3 atoms of oxygen, forming an azo oxy-nitro-diphenyl.

A. Baeyer, "On Phenanthren-quinon." By boiling with soda this body takes up a molecule of water, and forms an aldehyd acid of the formula $C_{14}H_{10}O_3$.

T. Heymer, "Action of Sodium on Succinic Ether, and a Peculiar Formation of Hydroquinon." By the action of sodium a complicated ether, analogous to aceto-acetic ether, is produced. If treated with soda and sulphuric acid while protected from the action of the air, it yields hydroquinon. With acetic acid, and an incomplete exclusion of air, an acid of the following composition is obtained: $C_6H_4O_2(COOH)_2$.

A. Baeyer, "On Aldehyds of the Phthalic Acids." The author obtains them from the acid chlorides by treatment with hydriodic acid and phosphorus.

J. Berger, "On Oxy-terephthalic Acid." This compound, $C_6H_3(OH)(COOH)_2$, was obtained from the diamido compound, and gives with HCl oxy-salicylic acid.

F. C. Muller, "On the temperature of Aqueous Vapor under Normal Conditions." Experiments show that there is no condensation of water upon the bulb of a thermometer surrounded by aqueous vapor and marking 100°, if it be previously warmed to that temperature. and condensation upon the upper part of the tube be prevented.

C. Göttig, "On the Synthesis of Aldehyds." The author applies successfully the method of distillation of calcium formiate with the calcium salt of the corresponding acid to the synthesis of ethyl-salicyl-aldehyd,—

$$C_6H_4(OC_2H_5)(COH),$$

but is unable to obtain salicyl-aldehyd itself.

H. Schwanert, "Dinitro-toluen-sulphonic Acids." The author has obtained two isomeric acids of this composition, $C_6H_2(CH_3)(NO_2)_2(SO_3H)$, one of which, dinitro-para-toluen-sulphonic acid, derived from ortho-nitro-para-toulen-sulphonic acid by the action of HNO_3, is described fully. A number of salts, the amide, chloride, and various compounds with acids, as are also described.

A. Bernthsen, "Action of Nascent Hydrogen upon Benzo-thiamide." Sodium amalgam in an alcoholic solution reduces benzo-thiamide to benzo-thialdehyd, $C_6H_5.CSH$.

B. Zöller, "On the Conservatory Properties of Potassic Xanthate." A small addition of this salt is found sufficient to prevent decay and fermentation in organic bodies for an indefinite period. The juice of the grape and other fruits can be preserved in this way perfectly fresh, even when exposed to the air. On account of its cheapness, easy application, absence of dangerous properties, and the small amount required, potassic xanthate can well replace many conservatory substances at present in use.

A. Raab, "On some Derivatives of Cuminic Aldehyd." Among these are dicuminyl-carbamide, $CO(NHC_{10}H_{13})_2$, dicuminyl-sulpho-carbamide, and hydro-cuminoin, $C_{20}H_{26}O_2$. The latter was obtained by reduction of the aldehyd with nascent hydrogen, and gives acetyl-, chloro, and other derivatives.

K. Stuckenberg, "On Para-nitro-ortho-sulphi-phenol." This body has been obtained in the form of the calcium salt, $C_6H_3NO_2SO_2OCaO$, by the action of nitric acid upon the potassium salt of ortho-sulphi-phenol.

B. Radziszewski, "On the Phosphorescence of Lophine, Amarine, and Hydro-benzamide." The author has found that, if lophine is dissolved in an alcoholic solution of potassic hydrate, an exceedingly brilliant phosphorescence takes place. An extensive series of experiments showed that the phenomenon did not occur in other solutions of lophine, or by the action of heat or friction; also that it was partially due to a slow process of oxidation, although not entirely. Ammonia and potassic benzoate were the decomposition results of the reaction. Amarine and hydro-benzamide displayed the phenomenon under the same conditions, but much less brilliantly. The author attributes it to causes analogous to those inducing the phosphorescence of phosphorus itself.

R. Struve, "Derivatives of Phenanthren." The author has obtained from phenanthren-quinon dinitro-phenanthren-quinon, a heavy yellow powder, and changed this by oxidation into dinitro-diphenic acid:

$$C_{12}H_6(NO_2)_2(COOH)_2.$$

Reducing agents yield a diamido-diphenic acid, a white amorphous powder, the hydrochlorate of which gives by distillation with soda-lime diamido-diphenyl.—*Chemical News.*

ACTION OF HEAT ON QUERCITE.

By M. L. PRUNIER.

IN the first stage, which extends to +280° in a vacuum the substance loses water, and there are formed neutral compounds, among which is found a volatile body—quercitic ether. All the compounds formed are neutral, soluble in water, insoluble in alcohol and ether, and regenerate quercite if boiled in water. Above 280° to 300° the molecule is abruptly broken up; carbonic acid escapes, and there are formed crystalline acid bodies, more volatile and more fusible than quercitric ether.

PHOSPHORUS.

In the whole list of chemical elements none is more remarkable, more unique, than the *light-bearer*, our well-known phosphorus. Had Prometheus discovered and separated phosphorus, it might well have given rise to the story that he stole fire from heaven, for phosphorus and fire are almost synonymous, the former being scarcely able to exist without giving rise to the latter.

Phosphorus is classed with nitrogen because of its atomicity, both acting either as triads or pentads. But in most of its properties it would scarcely be possible to imagine two substances more unlike than phosphorus and nitrogen. The former is a solid at ordinary temperatures, the latter is always a gas; the former has such an affinity for oxygen that it must be kept excluded from it, the latter is quite unwilling to combine with oxygen except under the most pressing circumstances; the former is a violent poison, the latter perfectly harmless; phosphorus is always found in combination, most of the nitrogen is in a free state. Where then is the resemblance? These elements each form two oxides, P_2O_3 and P_2O_5 corresponding to N_2O_3, and P_2O_5 corresponding to N_2O_5, and all these oxides combine with water to form acids; hence they are called anhydrids. Both phosphorus and nitrogen combine with hydrogen, the former producing PH_3 and the latter NH_3; the former is very combustible, the latter will burn only in pure oxygen. NH_3 is extremely soluble, PH_3 but slightly soluble, in water; both gases can be condensed to liquids, neither to a solid.

Phosphorus combines with most of the metals to form phosphides; nitrogen combines with but few of them, directly at least. Of the phosphides, one of the longest known is calcic phosphide, formed by passing vapors of phosphorus over quicklime at a red heat; this substance when thrown into water easily decomposes the water, and an evolution of phosphoretted hydrogen takes place. Several phosphides of zinc have been prepared, and some have been proposed for use in medicine. Phosphorus and sodium unite when heated together under melted paraffine. A ferric phosphide, Fe_4P, is obtained by heating phosphate of iron with charcoal. The use of phosphorus in alloys is attracting much attention at present, especially a compound known as phosphorus bronze, for cannons, axles, journals, etc.

If phosphorus is totally unlike nitrogen in many of its properties, it resembles more or less closely many of the metals in various other properties. Its melting point 110° F. (44° C.) is not far above that of the newly discovered gallium. In electrical properties it stands between the semi-metals, arsenic and selenium, but it is less like a metal than either of them. Its specific gravity, 1·823, is very nearly that of barium, which is 1·85, and a little greater than that of magnesium. The specific heat of phosphorus is 0·1887, or about twice that of copper, and is intermediate between aluminium and sulphur. The solvents of sulphur likewise dissolve phosphorus.

Phosphorus is manufactured in only one establishment in this country, that of Rose & Lowell, on Rancocas Creek, Burlington County, N. J. England has one manufactory, that of Albright & Wilson, near Birmingham; and France one, that of Coignet & Son, in Lyons; there are none in Germany or Austria, where formerly there were several. The total production of England and France, in 1873, was 1,200 tons of phosphorus, in the manufacture of which 15,000 tons of bones were consumed. That so small a quantity of phosphorus should suffice to supply the world with so many millions of matches is not strange, when we consider that a pound of phosphorus will make two million matches, and 1,000 lbs. will supply a large factory for a year.

The manufacture of phosphorus is one requiring the utmost care, and the expense of the apparatus with cost of skilled labor renders it an unattractive business. The operations are not as complicated as are the chemical reactions supposed to take place. Bones, from which the fatty matter has been extracted by superheated steam, and which may have since served a useful part, as bone-black, in the manufacture of sugar, are heated in muffles until nothing remains but mineral matter, calcic triphosphate, carbonate, etc. The white burned bones are next ground to a coarse powder, known as bone-ash. This substance is totally insoluble, and must be decomposed by means of an equal weight of sulphuric acid, of specific gravity 1·52 or a smaller quantity of stronger acid. This removes two thirds of the calcium, with which it combines to form an insoluble sulphate, leaving the calcic monophosphate (so-called superphosphate) in solution. The reaction is as follows:

$$Ca_3(PO_4)_2 + 2H_2SO_4 = CaH_4(PO_4)_2 + 2CaSO_4.$$

The liquor is decanted, and, along with the first washings, evaporated in leaden pans to a specific gravity of 1·45=45° B. It is then mixed with 20 or 25 per cent. of granulated charcoal, of the size of small peas, and quickly dried in cast-iron pots. This mixture is afterwards distilled in fire-clay retorts. The heating is gentle at first, but is afterwards raised to a full white heat, and lasts for 46 hours. Each retort holds from 12 to 20 lbs. of the mixture. The retorts are placed in furnaces, twelve on each side, with the neck projecting through the side of the furnace, which must be removed at each refilling. The receivers, which are attached to the neck of the retorts, dip into water which is kept at 110° to prevent the phosphorus from solidifying as it distils over, and thus stopping up the passage.

The purification is accomplished in France by filtration through charcoal and pressing through wash-leather. In Germany it is purified by redistillation in iron retorts. It is next cast into sticks, either by sucking it up into glass tubes or casting under hot water in tubes, which are at once transferred to cold water.

Perhaps the most remarkable property of phosphorus, next to that which gives it its name, is the ability which it possesses of assuming various allotropic forms, under apparently trifling causes. The most useful of these is the red or amorphous form, obtained by heating it for 30 or 40 hours to a temperature of about 230° C. or 446° F., in carbonic acid or neutral gas. It may be prepared in several other ways, and was first observed by Berzelius, who noticed that phosphorus, under the influence of colored light, acquired a red color and lost its property of shining in the dark. In 1844 Koop obtained some of this substance when preparing iodide of ethyl by treating alcohol with iodine and phosphorus. It did not attract much attention until 1858, when Schrötter prepared it by heat as above described. Brodie afterwards prepared it by heating phosphorus with a small quantity of iodine in a sealed tube or in carbonic acid; also by melting phosphorus under strong hydrochloric acid and then adding a small quantity of iodine. At 260° C. (500° F.) this red modification returns to common phosphorus and, if air is present, takes fire.

Red phosphorus is insoluble in carbonic disulphide, in which ordinary phosphorus readily dissolves; it is not a poison, does not oxidize in the air at common temperatures (and hence does not require to be kept under water), is not luminous, and emits no odor; all of which properties are the very opposite of those of common phosphorus.

White phosphorus is formed when phosphorus is exposed for some time to light, under water. It is less fusible than common phosphorus, but is reconverted into the latter at 50° C. (122° F).

Black phosphorus is another modification produced by sudden cooling of melted phosphorus. It is restored to the colorless state by melting and cooling slowly. Some authorities claim that this modification is only produced when arsenic or other metal is present; Blondlot, however, states that it is a type of pure phosphorus. This black modification may also be obtained by distilling ordinary phosphorus with a trace of mercury, or by heating it on a water bath for several hours in contact with mercury under water.

About three years ago Prof. E. J. Houston discovered another allotropic form of phosphorus, obtained by boiling it in strong solution of potassic hydrate for five or ten minutes. The phosphorus is then carefully washed with running water, and when purified it retains its liquid condition, even when cooled considerably below the melting point of ordinary phosphorus.

Other observers have described still other allotropic forms, but they have not been carefully studied and may have been merely impure forms of phosphorus. The author has observed that sticks of phosphorus kept under water in closed bottles, and in the dark, frequently become covered with a black crust which readily peels off on being handled. The cause of this change has not yet been ascertained, but may have been due to impurities in the water, as phosphorus possesses remarkable reducing properties.—*Boston Journal of Chemistry.*

THE CHEMICAL HARMONY OF THE UNIVERSE.

Dr. T. Sterry Hunt lately gave a very interesting address before the Chestnut Street club, Boston, in the parlors of Mrs. J. T. Sargent. His subject was the balance and unity of the chemical forces in nature.

In introducing the lecture, Dr. Hunt spoke of the growing belief in the unity and harmony of the forces throughout the universe. Ancient alchemists believed in this unity. Later on, science did not recognize it; but now, again, it reasserts itself. The notion of the independence of everything in nature has taken the shape of discussion upon what are called the efficient and final causes. Dr. Hunt then spoke of the idea of some thinkers, that all the order of the universe finds its perfection in man, and is made for his use; and of the opposing idea, that man is only a phase in the successions upon the earth, and may as truly be said to exist for the good of the animals or to maintain the balance between the animal and vegetable worlds. All teleological reasoning is open to such contradictions so far as it attempts to explain the universe.

The chemical, physical and vital forces of our earth, he said, leading directly to the central thought of the lecture, seem at first sight to have no influence outside of it, but the spectroscope and telescope tell us of like forces in far-away worlds. Great masses of vapor and nebulous matter in space condense to form suns and planets, and these cool till bodies are formed like our moon. By the spectroscope we are led to conclude that these far-away bodies have atmospheres like our own, that rains like our own must fall, and that animals in other worlds must breathe an atmosphere like our own. The latest speculation of chemistry leads us to conclude, he said (and this fresh thought ran through the hour and shaped the questions which followed), that the chemical elements of the earth are themselves the product of growth or evolution from simpler elements, probably like those in our atmosphere. The so-called simple elements are not simple. A cosmical chemistry or evolution is continually going on. As we follow the change of condition through the white, yellow, and red stars, we approach nearest the chemistry of our earth.

What are nebulæ? They have been believed to be elementary forms; but if we suppose that the envelope of the earth is continued beyond the farthest star—and this idea is not a rash one; it has been put forward by the best thinkers of the day; Sir William Thompson has admitted that the mathematical argument is in favor of the opinion—then the formation of nebula, sun and star is as simple as the formation of a rain drop. When there is a condensation of vapor in the atmosphere rain collects and falls. A like condition may occur in this ether when a nebula is formed. Some cause in the interstellary ether induces this condensation; chemical and physical forces are at work till a sun is formed, and the worlds are thrown off from the central mass.

In the planet Mars we see the same chemical and physical forces at work as on the earth. It has summer and winter, rain and snow. In aerolites we find evidence of the same chemical forces which have formed our earth's rocky masses, and in them we also find evidences of animal and vegetable life existing as on earth at present. There was a time when the earth had cooled down to the point at which it was a solid mass, but when all the waters and most of the solid matter of the ocean was volatilized. It was a homogeneous mass. All rocks and minerals were only so *in posse*. There was no atmosphere as we have it to-day. The chemical and physical forces began to work. With the cooling of the earth there came down from the atmospheric envelope the first rains, charged with corrosive acids. Chemical reaction began, and continued till the affinities of these acids were exhausted. Then was formed by these rains the sea, which, with the solutions it held, was utterly unfit to sustain life. The atmosphere was gradually purified till it approached its present condition; but even now it contains elements which gnaw away the hard granite. Carbonic acid was far more abundant in the past than now, and it worked upon the rocks, which were one of the first results of the rainfall. Under the acid the rocks decayed, and formed clay and alkalies. These alkalies rapidly absorbed the carbonic acid, and this process is still going on. Waters with the dissolved rock in solution poured into the sea, changing it till it became fit to support life. Salt and limestone were generated in it. Clay was also left upon the land, and through the continuation of this process, in atmosphere and upon land, life upon land became possible. Ocean life in its earliest forms was in corals and mollusks. Only after the purification of ages were higher forms possible, and it was ages more before the lowest form of vegetation was possible on land. In time the hugh reptiles and land animals came and passed away, and in a purer atmosphere we have higher vertebrate animals.

Dr. Hunt then discussed at some length the cooling of the earth, and incidentally opposed the idea of the prevalence of great glacial periods when a large part of the earth's surface was covered with ice. Further on he spoke of the high use of the little amount of carbonic acid in the atmosphere to retain the heat from the sun and give life to plants. If this should be withdrawn, all life would soon cease. We are keeping a pretty even balance now. Coal-burning adds to the stock of this acid continually; but, again, it is being continually washed down into the sea. It is difficult to weigh these agencies and say what is to be the fate of the earth, but unless we can invoke new agencies it looks as if we should soon reach the limit of human development. We cannot escape the conclusion that the present order of things is temporary. We are but links in a chain. We cannot see the end. Only He who sees the end from the beginning knows what is in the future.

Quite a brisk conversation followed the lecture, conducted by the gentlemen above mentioned. Answering a question of Mr. Weiss, Dr. Hunt stated that he does not think the precession of the equinoxes, or the nutation of the poles, sufficient cause for the great variations in the temperature of the earth. With Mr. Longfellow the query was about the glacial theory, the leading point of Dr. Hunt being given above. Replying to Dr. Bartol's inquiry, Dr. Hunt stated that in the simplest nebulæ only hydrogen and nitrogen are found, and it is thought that back of these—their origin—may be a substance which has been named *helium*. All matters may be generated from this one original substance, and the presence of additional elements in the cooling stars supports this view. This subject of one original matter led back to the mind behind that, and conversation on immortality and kindred thoughts, the Rev. Joseph Cook and his proof of immortality coming in for criticism.—*Boston Weekly Advertiser.*

TESTING OF SALICYLIC ACID FOR PURITY.

By H. Kolbe.

Only absolutely pure crystallized salicylic acid should be used either internally as a medicine or as a preservative for wine, beer, fruits, etc. The less pure acid, which generally has a peculiar after-taste when used continually or given in large doses, may act injuriously on the health. The prejudice against salicylic acid of physicians who have failed to obtain good results with it is due in most cases to the pharmacist having dispensed an impure preparation—the precipitated instead of the crystallized acid. The author has met with several cases in which such an acid was used. He therefore gives the following simple method of judging of the quality of commercial salicylic acid: Dissolve a small quantity, ½ gram, in about ten times as much strong alcohol, pour the clear solution into a watch glass, and leave it to evaporate slowly at the ordinary temperature of the atmosphere. The residual salicylic acid forms around the edge of the watch glass a ring of beautiful efflorescent aggregated crystals. This efflorescent mass is pure white if the acid used be quite pure and has been recrystallized; but yellowish or yellow if the simply precipitated acid be used. If the color be brownish or brown, the preparation, however white and pure it may appear as a powder, should be rejected as bad.—*Schweizerische Wochenschrift f. Pharmacie.*

CARBONIC-ACID GAS AS A FIRE EXTINGUISHER.

Since ordinary combustion consists in the more or less rapid combination of the oxygen of the air with the combustible substance, it follows that, if the air be excluded from the burning body, the combustion must necessarily cease. Hence have arisen various methods for the rapid extinguishing of conflagrations, which, though different in their methods, all agree in one respect, viz., in replacing the air and its containing oxygen by some substance incapable of supporting combustion. This replacing may be partial or total.

Various substances have been employed for this purpose, among which, besides water, may be mentioned sand, earth, nitrogen, sulphurous acid, steam, ammonia, coal gas, and carbonic acid. These either contain no oxygen at all, or if present, contain it in such conditions that it cannot be readily separated from the body with which it is combined.

Passing by most of the substances just named, as inapplicable either from their cost, their difficulty of being readily obtained in large quantities, their destructive action on the goods they save from combustion, or their deleterious influence on life, even in small quantities, we will consider the applicability of carbonic-acid gas to fire extinguishing.

The objections made against water and steam in quenching fires have brought in use carbonic-acid gas for such purpose, as a safe, harmless, cheap and speedy extinguisher, though by no means free from serious drawbacks; and its application is limited to checking a fire when first started, rather than when any headway has been gained.

Carbonic acid, or carbonic dioxide, is a gaseous substance, formed by the combination of one atom of carbon with two of oxygen. It is produced whenever carbon, in any of its forms, is burned with free access of air. Nearly all the substances used for fuel or for lighting purposes, such as coal, peat, wood, oil, wax, tallow, illuminating gas, etc., etc., contain carbon, and produce carbonic acid as a result of their combustion. Carbonic acid is evolved in the kilns used for the burning of limestone, marble, and oyster shells; these substances being composed of lime and carbonic-acid gas, the latter being driven off by heat. Carbonic acid is given off during the respiration of animals, during fermentation of bread, beer, etc. It is also given off from fissures in the earth in various localities, especially in the neighborhood of active volcanoes. Freshly cut surfaces of coal have the power of emitting large quantities of this gas. From all these various sources atmospheric air is invariably found, no matter from what locality it may be taken, to contain a small quantity of carbonic acid, viz., about from four to six volumes in every ten thousand volumes of atmosphere.

This gas has the following properties: It is, at the ordinary pressure of the atmosphere and common temperatures, colorless and transparent; its weight is rather more than one and one half times that of air; its specific gravity, according to Regnault, being 1·5241. It does not support combustion; a burning taper or candle plunged into a jar of the gas is, as well known, instantly extinguished, from the absence of that freed oxygen on which its continued burning depends. Although oxygen is present in the carbonic acid, it is combined with the carbon, and cannot therefore affect the combustion. It is, as it may be said, already burned—that is, combined with the carbon. When diluted with three times its bulk of air, it will still extinguish flame. Carbonic acid is irrespirable. Death soon results to animals when placed in an atmosphere of the pure gas, and in many cases in gas which is considerably diluted with common air. Whether this results from the directly poisonous nature of the gas, or from the mere exclusion of oxygen, appears to be still a vexed question, though comparatively late investigations appear to establish the non-poisonous character of the gas when

breathed under such conditions as will admit of mixture with air or oxygen.

Carbonic acid, from its great weight, can be readily collected in a tall jar placed with its mouth upwards. The gas falls to the bottom of the jar, displacing the lighter air, which overflows at the mouth; very much in the same way that we might take a vessel filled with any oil lighter than water, and, by pouring water in the vessel, gradually displace all the oil. Since the gas is colorless, we cannot see when the jar is filled, but a lighted candle carefully lowered into the jar will be extinguished at or near the upper surface of the gas, whose height can be thus determined. The gas, once collected, can be simply poured from one jar to another, just as we would pour water, greater care being necessary, however, to avoid loss by spilling.

An instructive experiment, bearing on the fire-extinguishing properties of the gas, may be made by lighting several candles, and placing them near together on a table, or some other convenient support. A moderately large jar, filled with carbonic-acid gas, is then placed near the candles and emptied over them, and they are almost invariably extinguished. Now, relighting them, take another jar of the gas, and hold it above the candles, but more distant from them than before, and, although the candles may be extinguished, it will be found that this action is not so certain as at first. Similar experiments, with the jar held further and further above the candles, will show that the certainty of extinction of the flame decreases very rapidly with the increased distance of the jar from the candles, until at last a position will be found at which the gas, unless largely increased in amount, will be unable to put out the lights. The cause of this failure is to be attributed to the mingling which occurs between the gas and the air. It would follow, therefore, from these experiments, that carbonic acid, in the ordinary condition of a gas, would not be applicable to the extinguishing of fires, it it had to be thrown on them from any considerable distance, since by such means it would become even more thoroughly mixed with air than when quietly poured on the fire from above.

If instead, as above, the candles be placed in a tight box, open at the top, and the gas poured on them from above, it will be found that they will be more readily extinguished than when placed on the open table. The reason is evident: the sides of the box prevent the influx of air currents, and serve also to retain the gas. In burning inclosures, therefore, fires can be extinguished if any means exist of pouring or throwing a large quantity of carbonic acid into the tightly inclosed structure from above. It might possibly be advantageous in some buildings to have each of the stories furnished with a ready means of pouring a large volume of carbonic-acid gas into any one of the stories. The supply can, however, be easily obtained by the action of sulphuric or hydrochloric acid on marble chippings, sodium bicarbonate, or any readily decomposed carbonate. The acid and carbonate could be kept in separate vessels, so arranged that they could be readily mixed, and tubes connected to the chamber containing the mixture led to different parts of the building. This plan has, indeed, been actually applied by various parties for extinguishing fires in the holds of vessels. It may be seen that the shape of a ship renders such a plan especially applicable, since the retention of the dense suffocating gas is secured. In one plan, which we believe is the earliest, boxes with perforated sides, so as to admit of the escape of the gas, are placed in various positions in the hold of the vessel, and connected to the deck by long copper tubes. When a fire is discovered in the hold, sulphuric acid is run into the boxes, and the carbonic acid which is generated, flowing out of the boxes, collects in the lowest part of the hold, and extinguishes the fire there.

Plans similar to the foregoing, as say the pyroletor of Patten & Harris, are not, however, applicable to the generality of fires which occur on the land. The difficulty of access to the fires in most cases renders it necessary to throw the carbonic acid for some distance at the fire. Though heavier than air, this gas is of not sufficient weight to render such projection possible.

Pure water, at ordinary temperature, will dissolve about its own volume of carbonic-acid gas, making a solution whose specific gravity is 1·0018. The solution readily parts with the gas as the temperature is raised. As the pressure is increased, water will dissolve a larger and larger quantity of the gas. The pressure thus secured in the fire-extinguishing cylinder, the subsequently escaping gas forces the water upon the fire. The availability of the gas liquefied by pressure as an extinguisher remains to be considered.—*American Exchange and Review.*

PRESERVATION OF EGGS.

The sure and simple method of keeping eggs sound by smearing the shells with linseed oil has long been practised. The oil forms a sort of film over the shell, thereby preventing the two immediate causes of decomposition—evaporation from and penetration of air into the egg. A recent experiment in point deserves notice. A dozen new-laid eggs were rubbed over with linseed oil applied with the tip of the finger; another dozen were coated in like manner with poppy oil; two or more eggs were left in their natural state. The whole 22 were then laid close together, in three rows, on dry sand upon a shelf, where they were left undisturbed. At the end of three months they were weighed, and again at the end of six months, when they were opened. The two eggs left in their natural state at the end of three months had lost 11 per cent. of their weight, and at the end of six months 18 per cent., and were found to be half empty and half the contents rotten. The eggs coated with poppy oil in three months lost three per cent., and in six months 4½ per cent. of their weight. The eggs were still full, and devoid of unpleasant smell. The eggs rubbed over with linseed oil in three months lost 2 per cent., and in six months 3 per cent. only of their weight, and when opened were found to be full, with the smell of fresh eggs.—*Pharm. Centralhalle für Deutschland.*

Ammonia in Cast-Steel.—M. P. Regnard.—On breaking up ingots of steel made on Pousard's system the author noticed a very decided smell of ammonia. The odor was accompanied by a slight hissing, very distinct on holding the ingot to the ear. On covering the fracture with soap-water a froth was produced. These phenomena were witnessed by several persons, especially MM. Troost and Hautefeuille

Mr. W. C. Roberts, of the London Physical Society, has found that beautiful hexagonal columns may be formed by heating masses of clay and sand up to about thirteen hundred degrees Centigrade, and then allowing them to cool. They contract like basalt as they pass from a molten into a solid state.

[Nature.]

CHEMICAL NOTES.

Atomic Weights of Caesium and Rubidium.—M. Godeffroy gives an account in Liebig's *Annalen* of some determinations he has made on the above subject. To obtain pure material he employs Redtenbacher's method for the separation of the caesium, rubidium, and potassium, by preparing their respective alums, separating these by fractional crystallization, and finally converting them into pure chlorides of the metals. The determination of chlorine in the non-diliquescent caesium chloride, gave, as the mean of four closely agreeing experiments, the atomic weight or caesium as equal to 132·557, the atomic weights of chlorine and silver being taken as 35·46 and 107·94 respectively; from analogous experiments the author finds the atomic weight of rubidium to be equal to 85·476.

On the Specific Heat of Gases.—In *Poggendorff's Annalen*, clvii., E. Wiedemann gives a most interesting communication on this matter, in which he criticises the experiments of Regnault on the same subject, and describes a new method of determining the specific heats of gases introduced by himself. On comparing the author's results with those of Regnault it is found that the method employed by the former is not inferior in accuracy to that of Regnault, and also that a great economy of material may be effected by using Wiedemann's process; this economy giving the experiments greater range in a comparatively shorter time. The following tables give a synopsis of the numbers and numerous tables given in Wiedemann's paper:

Specific Heats of Equal Weights.

	I.	II.	III.	IV.
	0°	100°	200°	
Air	0 2389	—	—	0
Hydrogen	3·410	—	—	0
Carbon monoxide	0 2426	—	—	0
Carbon dioxide	0·1952	0·2169	0·2387	22·28
Ethylene	0 3364	0·4189	0·5015	49·08
Nitrous oxide	0 1983	0·2212	0·2442	23·15
Ammonia	0·5009	0 5317	0·5629	12 38

Specific Heats of Equal Volumes.

	V.	VI.	VII.	VIII.	IX.
	0°	100°	200°	Specific weight.	$\frac{P\,V}{P'\,V'}$
Air	0·2389	—	—	1	1·00215
Hydrogen	0·2359	—	—	0·0692	—
Carbon monoxide	0·2346	—	—	0·967	1·00293
Carbon dioxide	0·2985	0·3316	0·3650	1 529	1 00722
Ethylene	0·3254	0·4052	0·4851	0 9677	—
Nitrous oxide	0·3014	0·3362	0·3712	1·5241	1·00651
Ammonia	0·2952	0 3134	0·3318	0·5894	1·01881

Columns I., II., III., contain the true specific heats at the temperatures indicated; column IV. the difference of specific heat at 0° and 200° expressed in percentage of the specific heat at 0°. Columns V., VI., VII., represent the true specific heats in reference to the unit of volume, the specific heat of the unit volume of air being taken as 0·2389; column IX. gives Regnault's proportions of the products of the volumes V and V', and the pressures P and P', when P is at the pressure of one, and P' at the pressure of two atmospheres. Herr Wiedemann thinks that the specific heat determined in these experiments seems to be composed of two parts: the heat caused by work expended on the expansion of the gases in overcoming outside pressure, and secondly, the heat employed in the internal work of the gas itself. He also thinks that attempts to determine the separate parts of the heat of molecular motion, of which the specific heat is composed in constant volumes—of the heat of atoms according to Naumann—and also the attempt to establish simple relations between the two to be still premature, as the alteration of the specific heat with the temperature would cause these effects to have different relations between different temperatures. The author thinks that the alteration of specific heat of the gases with the temperature cannot be explained by the deviation of such gases from the perfect gaseous condition. As an illustration of this, he cites the case of ammonia gas, which, although more remote from the state of a perfect gas than nitrous oxide or carbon dioxide, still possesses smaller variations of its specific heat with change of temperature than either of these latter gases.

Action of Antimony Pentachloride on certain Organic Substances.—The action of this reagent on some organic substances has lately been investigated by C. W. Lossner, who gives an account in the *Journ. pour Chimie* of the results he obtained. When chloroform and antimony pentachloride are gently heated together, preferably in sealed tubes to 100° C., the chloroform becomes converted into carbon tetrachloride. Ethyle bromide is attacked by antimony pentachloride, the whole of the bromine being liberated and ethyle chloride formed. The action of antimony pentachloride on ethene bromide differs according to the quantities employed. With the same number of molecules of the two substances the chief product is ethylene chlorobromide, while with two molecules of pentachloride to one of ethene bromide the product is ethene chloride. Ethene bromide is not acted on when similarly heated with phosphorous pentachloride. The product of the reaction of acetic acid with antimony pentachloride is monochloracetic acid, accompanied by another substance with a higher boiling point. When salicylic acid is gradually added to antimony pentachloride, monochloro- and dichloro-salicylic acids are produced along with other products; monochloro-salicylic acid is found in small quantities only. Dichloro-salicylic acid, on being boiled with potash for a considerable length of time, exchanges its chlorine for hydroxyl, yielding gallic acid accompanied with pyro-gallic and oxy-salicylic acids. When paraoxybenzoic acid is acted on by two or four molecules of antimony pentachloride the mono- and dichlorinated acids are found respectively. From these reactions it is evident that the action of antimony pentachloride differs from that of its analogue, phosphorous pentachloride, since it simply parts with its chlorine, which replaces hydrogen in the acid radical, instead of replacing the hydroxyl group by chlorine, as is generally the case when phosphorous pentachloride acts upon organic substances.

Action of Chlorine on Peroxydes.—MM. Spring and Arisqueta continue (*Bull. Acad. de Belg.*, xlii. p. 565) their researches into the action of chlorine on peroxydes of metals, for the purpose of elucidating the very important question whether the atomicity of certain bodies is variable (as supposed by Kolbe and Blomstrand), *i.e.*, whether whilst one atom of a body in a molecule is, say, tri-atomic, and possesses basic properties, another atom of the same body may be pent-atomic and partake of the properties of an acid, or whether the atomicity remains invariable, as supposed by Kékulé and the author of the paper. Former researches induced M. Spring to conclude that the atoms of chlorine possess constantly the same properties in all their compounds with oxygen, which would be contrary to the alleged varying atomicity. Now, studying the action of chlorine upon the peroxyde of silver, the authors prove, by a very delicate experiment, that its result is the formation of a peroxyde of chlorine, a body previsєd by the theory, but unknown until now; and they conclude, therefore, that the structure of peroxydes of silver and of chlorine is identical, which identity gives a new argument in support of the invariability of the atomicity of chlorine and silver.

Boron and its Specific Heat.—Boron occurs, it is known, in two different forms, in the amorphous state, and in crystals. M. Hampe has recently found (*Liebig's Annalen der Chemie*) that both the black and the honey-yellow crystals are not pure boron, but compounds of the element; the black crystals consisting of albuminium and bromine in the proportions BlB_{12}, and the yellow crystals of aluminium, carbon, and boron, $C_2Al_3B_{48}$. Boron has hitherto been numbered among the few elements which show a departure from Dulong and Petit's general law of the constancy of specific heat into atomic weight, and M. Weber sought the reason for this departure in the case of boron, as in those of carbon and silicon, in the fact that the specific heat varies with the temperatures, but at high temperatures reaches a value which establishes an agreement with Dulong and Petit's law. The determination of the specific heat of boron, however, as also M. Weber's experiments, were made with crystals of boron. Now, since, according to M. Hampe, these crystals are not pure boron, but compounds of it, the whole question as to the validity of Dulong and Petit's law for the pure element boron, remains an open one. All the attempts made by M. Hampe to produce pure crystallized boron had been without success. He is engaged in further investigating whether the amorphous boron can be produced in absolute purity.

Heated Air.—Dr. Kayser, of Nuremberg, has lately conducted a number of experiments upon the effects of heating ordinary air, with especial reference to the warming of dwellings. The results appear in the last report of the Munich Industrial Museum, and may briefly be summed up as follows: Air previously free from carbon monoxide was invariably found to contain this gas after heating. The tests were performed with chromic acid, and also with cuprous chloride. In order to test the products of the decomposition of the dust present in the air, about sixty litres of air, which had been heated, were drawn through an ordinary apparatus for determining carbonic acid, which contained absolute alcohol. The liquid assumed a yellowish brown color, and flaky masses were suspended in it. The flakes were found to consist chiefly of carbon. After filtration and evaporation of the solution, a brown residue was obtained. This was insoluble in water, intensely acrid, and possessed a resinous, empyreumatic odor. The estimations of carbonic acid and water, before and after heating, showed no difference worthy of mention.

NEW THINGS IN THE ARTS.

Something New in Navigation.—A new system of navigation has been sketched by M. Tommasi in *Les Mondes*. The proposed vessel holds a middle position between submarine vessels and those sailing on the surface. It consists chiefly of two parts—an upper part which is out of the water, and a lower part which is immersed. These are connected by two iron columns. The upper part, or platform, corresponds to that of an ordinary ship; the part in the water, or plunger, is in the form of a cylinder terminated at one end by a cone, at the other by a spherical surface; it is in three compartments, the middle one containing the motor engine, the two others merchandise. The lower part of the plunger has a reservoir for air or water, either of which is introduced by a pumping engine at will, so as to make the vessel rise or sink. The vessel is propelled by a screw in the plunger. Two tubes rise from the plunger, one for escape of smoke, the other for ventilation. It is claimed that the plunger, being wholly under water, will offer less resistance to traction, in a horizontal direction, than a body floating at the surface; that the action of the waves will not be felt, the plunger moving in nearly a straight line; that the motion of the propellers will both be more regular and more productive, and that it will not change the direction of the ship, or very little; and that the platform, being capable of separation from the plunger, may serve as a raft when the plunger may be injured by shock, fire, etc.

PERFUMERY.

By W. Saunders, of London, Canada.

The art of compounding perfumes is an ancient one. It was practised by the early Egyptians and other Oriental nations, and with them perfumes were in frequent use. In Holy Writ, Moses speaks of being directed to take sweet spices, stacte, onycha, galbanum, and frankincense, and confection them into a pure and holy perfume after the manner of the apothecary, to be offered up to the Lord ; and in Proverbs we read of epicures indulging in the luxurious use of costly perfumes. The Greeks and Romans used perfumes freely, as well on their persons as at their feasts; they were also used with flowers at sacrifices to regale the gods. These fragrant compounds were in demand for theatres and other places where crowded audiences assembled, when their use subdued the offensiveness of a vitiated atmosphere. Different nations preferred different odors ; with one the violet was most popular, whilst others gave preference to the rose.

From the frequent mention of perfume in the form of ointment, it would appear that the solvent powers of fatty matters over the odorous principle of flowers was among the earlier discoveries in this department. Subsequently fragrant waters were in great demand, and costly as these articles of luxury then were, they were nevertheless largely consumed. Grave men at times protested against the prevailing extravagance, and philosophers declared their aversion to perfumes

"There is the same smell," said Socrates, "in a gentleman and a slave, when both are perfumed;" hence, in his opinion, the only odors desirable were those arising from honorable toils, and "the smell of gentility;" but in spite of protests the wealthy perversely and persistently followed their own tastes, anointed their bodies, pomaded their hair, and bathed their limbs in fragrant waters, as though the thoughtful ones had never spoken.

In latter times, with the advance of civilization, the use of perfumes gradually extended to other nations, culminating in their general use throughout the civilized world. In some countries there was for a time stout opposition to the introduction of all such preparations. In England it was seriously thought to be a fit subject for legislative control. In 1770 an Act was introduced into the English Parliament as follows: "That all women, of whatever age, rank, profession, or degree, whether virgins, maids, or widows, that shall from and after such Act, impose upon, seduce and betray into matrimony any of His Majesty's subjects by the scents, paints, cosmetic washes, artificial teeth, false hair, iron stays, hoops, high heeled shoes, bolstered hips, shall incur the penalty of the law now in force against witchcraft and like misdemeanors, and that the marriage, upon conviction, shall stand null and void."

In large cities the manufacture and sale of perfumery is sometimes carried on as a separate occupation, yet as a rule this department of business, as in ancient days, is still associated with the trade and mysteries of the apothecary. Some may perhaps have but little sympathy with the manufacturer of perfumery, and may think that it were better handed over to the hairdresser or dealer in notions, and that the apothecary should devote his time exclusively to the more important duties of dealing out medicines, pure and simple, to meet the requirements of physicians and the wants of suffering humanity. This latter is doubtless the most legitimate and beneficent exercise of the apothecaries' skill, and ought always to be regarded as of primary importance; yet he will often have spare hours when he can enjoy the pleasures connected with the compounding and blending of odors, and at the same time develop a profitable and time-honored branch of his business.

The cultivation of the olfactories is an advantage to the pharmacist. The nose is an organ whose importance he cannot ignore in his business, and it is doubtful if better training can be found for it than in the compounding of perfumes. We all think it a gain to have a fine ear for music; why should we think less of an exquisite nose for odors? Surely this prominent member is as capable of cultivation as is the ear, not that an unusual development is desirable in either case, but rather the making the very best use of the organs with which we have been supplied. There are harmonies and discords in perfumes as in music; Piesse has reduced them to a scale which he calls the gamut of odors. "If," says he, "a perfumer desires to make a bouquet from primitive odors, he must take such odors as chord together; the perfume will then be harmonious."

For sometime past the tendency has been to turn over the manufacture of perfumes too much to the specialist. This has probably resulted mainly from two causes—first, the difficulty of procuring the materials used in the making of perfumes in a state of purity, and in the second place for want of plain and practical information on the subject. The first obstacle is less felt now than formerly, and to aid in the removal of the second is the main object of the present paper. My purpose is to place within the reach of every one of our members such information as will enable him with a little attention to equal the finest productions of a Lubin, an Atkinson, or a Rimmel.

I have now before me samples of twenty different extracts, any of which will, I think, compare favorably with the best of those imported. I shall first briefly refer to the ingredients which enter into their composition, and afterwards give the formulæ for their production.

Alcohol.—One of the first requisites in the manufacture of good perfumes is pure alcohol, free from fusil oil or other foreign flavor. The purer grade of spirit is known in commerce as pure spirits, silent spirits, or deodorized alcohol, and may readily be distinguished from ordinary alcohol by the absence of that peculiar pungency of odor which is present to a greater or less extent in most commercial samples.

Ottoes or Essential Oils.—It is of the greatest importance that these should be strictly pure and of the finest quality.

Pomades.—From these are prepared some of the simple extracts in the appended formulæ, such as jasmine, tuberose, and cassia. The quality must be that known as triple pomade. The simple extracts are prepared as follows: One pound of the pomade is cut in small pieces and placed in a bottle of sufficient capacity, in which is put a pint of pure spirit. Place the bottle, suitably stoppered, in a water bath, and apply heat sufficient to barely melt the pomade, shake well together, and repeat the shaking frequently until the fatty matter solidifies. In this way the pomade will be reduced to a finely divided or granular state, permeated thoroughly by the spirit. Allow this to stand for several days, giving it an occasional shake, then drain off the liquid extract into another bottle; if this fall short of a pint, repeat the operation with a sufficient quantity of alcohol to make up this measure. By subsequent and similar treatment, a second and even a third quantity of extract may be made, which, although much weaker, will be found useful in the preparation of cheaper perfumes.

Extract of Orris.—Seven pounds of finely ground orris root, of good quality, is treated by percolation with pure alcohol until one gallon of extract is obtained.

Extract Vanilla.—Four ounces of vanilla beans of the finest quality, powdered finely in a mortar with a sufficient quantity of dry white sugar (from four to six ounces), pack in a percolator, and percolate with proof spirit until one gallon is obtained.

Extract Tonka.—Take one pound of tonka beans, reduce to a coarse powder, and percolate with alcohol, to make one gallon.

Extract Musk.—Take of pure grain musk of the first quality two drachms. Mix half an ounce of liquor potassæ with four ounces of proof spirit, and triturate the musk with this mixture until it is thoroughly softened and reduced to a creamy state; add enough proof spirit to make up about one pint; stir well, then allow the coarser particles to subside, and pour off the supernatant fluid. Rub the coarser portions again with a fresh portion of spirit, proceeding as before, and repeat the process until the musk is entirely reduced, and the quantity of extract measures three pints. Allow this to stand for a fortnight, with occasional shaking, when it will be ready for use.

Extract Styrax.—Eight drachms of styrax balsam dissolved in one pint of alcohol.

Benzoic Acid.—Only that prepared from gum benzoin should be used.

FORMULÆ.

Jockey Club.

Ext. jasmin	5 ounces.
" orris	20 "
" musk	7 "
" vanilla	1¼ "
Otto rose, virgin	1¼ drachms.
" santal flav	1¼ "
" bergamot	2½ "
" neroli super	40 minims.
Benzoic acid	2 drachms.

Pure spirit, sufficient to make 4 pints.

In this, as well as the following extracts, before adding the last portion of the spirit, replace as much of it with water as the perfume will bear without becoming milky, which will vary from two to eight ounces or more. This addition will make the perfume softer.

Moss Rose.

Otto rose, virgin	2 drachms.
" santal flav	2 "
Ext. musk	12 ounces.
" vanilla	4 "
" oris	2 "
" jasmin	4 "
Benzoic acid	1 drachm.

Pure spirit, sufficient to make 4 pints.

White Rose.

Otto rose, virgin	2 drachms.
" red cedar wood (true)	6 minims.
" patchouly	4 "
" orange (fresh)	½ drachm.
Ext. tuberose	2 ounces.
" orris	2 "
" jasmin	2 "
" musk	2 "
Benzoic acid	1 drachm.

Pure spirit (to which 4 ounces of rose water has been added), sufficient to make 4 pints.

Victoria.

Otto rose, virgin	2 drachms.
" neroli super	2 "
" bergamot	4 "
" coriander	16 minims.
" pimento	24 "
" lavender (English)	16 "
Ext. jasmin	2 ounces.
" orris	16 "
" musk	2 "
Benzoic acid	2 "

Pure spirit, sufficient to make 4 pints.

Ess. Bouquet.

Ext musk	4 ounces.
" tuberose	2 "
Otto rose, virgin	1 drachm.
" bergamot	1½ "
" neroli super	½ "
" verbena (true)	8 minims.
" pimento	10 "
" patchouly	3 "
" red cedar wood (true)	½ drachm.
" lavender (English)	12 minims.

Pure spirit, sufficient to make 4 pints.

Musk.

Ext. musk	1 pint.
" orris	6 ounces.
" vanilla	2 "
" styrax	2 drachms.
Otto santal flav.	1 drachm.
" bergamot	2 drachms.
" neroli super	10 minims.
" patchouly	12 "
" lavender (English)	15 "
" cinnamon (true)	6 "

Pure spirit, sufficient to make 4 pints.

Patchouly.

Otto patchouly	2 drachms.
" santal flav	40 minims.
" rose, virgin	40 "
Ext. musk	8 ounces.
" orris	8 "
" vanilla	4 "
" styrax	2 drachms.

Pure spirit, sufficient to make 4 pints.

Millefleur.

Otto rose, virgin	1 drachm.
" red cedar wood (true)	1 "
" orange (new)	1 "
" pimento	20 minims.
Ext. orris	6 ounces.
" jasmin	2 "
" styrax	1 ounce.
" tonka	4 ounces.

Pure spirit, sufficient to make 4 pints.

Ylang Ylang.

Ext. tonka	3 ounces.
" musk	4 "
" tuberose	4 "
" cassia	4 "
" orris	8 "
Otto orange (new)	2 drachms.
" neroli super	½ drachm.

Pure spirit, sufficient to make 4 pints.

Spring Flowers.

Ext. orris	4 ounces.
" jasmin	4 "
" musk	4 "
Otto bergamot	2 drachms.
" neroli super	½ drachm.
" verbena (true)	10 minims.
" red cedar wood (true)	1 drachm.
Benzoic acid	1 "

Pure spirit, sufficient to make 4 pints.

Wood Violets.

Ext. orris	12 ounces.
" tuberose	2 "
" jasmin	1 "
" musk	4 "
Otto bergamot	2 drachms.
" lavender (English)	1 "
" verbena (true)	10 minims.
" amygd. amar	12 "
" coriander	6 "
" sweet flag	4 "
" bay leaves	4 "
Benzoic acid	1½ "

Pure spirit, sufficient to make 4 pints.

West End.

Ext. orris	12 ounces.
" jasmin	4 "
" musk	8 "
" cassia	4 "
" styrax	1 "
Otto bergamot	3 drachms.
" verbena (true)	15 minims.
" neroli super	½ drachm.
" rose, virgin	1 "
" red cedar wood (true)	1 "
Benzoic acid	1 "

Pure spirit, sufficient to make 4 pints.

Tuberose.

Ext. tube ose	24 ounces.
" musk	4 "
" jasmin	1 "
Otto rose, virgin	1 drachm.
" neroli super	10 minims.
Benzoic acid	2 drachms.

Pure spirit, sufficient to make 4 pints.

Stephanotis

Ext. cassia	4 ounces.
" tuberose	4 "
" jasmin	2 "
" musk	8 "
" orris	8 "
" tonka	3 "
Otto rose, virgin	1 drachm.
" neroli super	½ "
Benzoic acid	1 "

Pure spirit, sufficient to make 4 pints.

Rondeletia.

Otto lavender (English)	1 ounce.
" cloves	¼ "
" bergamot	½ "
" rose geranium (Turkey)	2 drachms.
" cinnamon (true)	20 minims.
" rose, virgin	10 "
" santal flav	1 drachm.
Ext. musk	2 ounces.
" orris	4 "
" vanilla	2 "
Benzoic acid	1 drachm.

Pure spirit, sufficient to make 4 pints.

New Mown Hay.

Ext. tonka	25 ounces.
" musk	6 "
" orris	8 "
" vanilla	1 "
" styrax	1 drachm.
Otto bergamot	1 "
" neroli super	15 minims.
" rose, virgin	10 "
" cloves	6 "
" lavender (English)	10 "
" patchouly	10 "
" santal flav	1 drachm.
Benzoic acid	1½ "

Pure spirit, sufficient to make 4 pints.

Frangipanni.

Ext. orris	4 ounces.
" tuberose	2 "
" musk	4 "
" vanilla	2 "
" jasmin	1 "
" styrax	1 "
Otto neroli sugar	1 drachm.
" rose, virgin	½ "
" santal flav	1 "
" red cedar wood (true)	1 "
" pimento	½ "
" cassia	20 minims.
" bergamot	½ drachm.
" ginger	4 drops.
" lavender (English)	6 "
Benzoic acid	2 drachms.

Pure spirit, sufficient to make 4 pints.

Clove Pink.

Ext. jasmin	12 ounces.
" orris	12 "
" musk	8 "
Otto rose, virgin	1 drachm.
" cloves	2 drachms.
" neroli super	1 drachm.
" pimento	10 minims.
" patchouly	20 "
" santal flav	2 drachms.
Benzoic acid	1 drachm.

Pure spirit, sufficient to make 4 pints.

Violet.

Ext. orris	2 pints.
" tuberose	4 ounces.
" vanilla	3 "
" musk	3 "
" tonka	2 "
Otto rose, virgin	1 drachm.
" neoli super	40 minims.
" pimento	12 "
" bergamot	1 drachm.
Benzoic acid	1 "

Pure spirit, sufficient to make 4 pints.

Mignonette.

Ext. orris	12 ounces.
" tuberose	4 "
" vanilla	4 "
" musk	2 "
Otto rose, virgin	1 drachm.
" neroli super	1½ "
" pimento	12 minims.
Benzoic acid	1 drachm.

Pure spirit, sufficient to make 4 pints.

GLASS GLOBES ON GAS-LIGHT.

THE desirability of protecting the flame of gas when burned in a room is obvious, but it should always be remembered that the advantages thereby obtained are secured at the expense of a certain proportion of light. This was shown recently in a paper read before the Newcastle-on-Tyne Chemical Society by Mr. John Pattison, who had noted the following results from experiments, all made with a light equal to fifteen standard candles:

	Illuminating power.	Percentage of light lost.
Naked flame	15·00	....
Clear glass globe	12·80	14·65
Ground glass globe	11·40	24·00
Opal globe	9·00	40·00
Another opal globe	8·16	45·60
" "	8·00	46·70
" "	6·64	55·90
" "	8·00	46·70
" "	7·48	50·10

The advantage arising from the use of globes or moons is that they diffuse and soften the glare of the naked light, which is sometimes oppressive to the eyes. Of the opal globes, Mr. Pattison considered the dead white semi-opaque one should be avoided. He recommended, as perhaps the best form of globe, that with a wide opening at the bottom, which allows a considerable amount of light to be reflected downwards from the white surface of the inside of the glass.

THE WALL-PAINTINGS OF POMPEII.

IN a recent lecture by the Rev. Henry G. Spaulding, delivered at the Lowell Institute, he spoke of painting as seen in the mural decorations of the Pompeiian houses. Several colored slides were used, showing these wall-paintings in their original colors, and giving to the audience a more accurate idea of the actual appearance of these ancient pictures than is afforded by the numerous faded frescoes in the museum at Naples. These colored slides have been prepared with great care, and with the utmost fidelity to the colors as copied by Zahn, when many of the walls were laid bare in the excavations carried on between 1828 and 1837. The execution of them by Mr. C. W. Briggs, of Philadelphia, is admirable and artistic, and the introduction of such copies of important paintings, so thrown upon the screen as to reproduce all the original colors, is a new and interesting feature of Mr. Spaulding's lectures.

The subject of antique painting, the lecturer said, has received only a cursory notice at the hands of critics and historians of art. Dr. Jacob Burkhardt, in the opening chapter of his excellent "Art-Guide to Painting in Italy," observes that "the remains which exist of the paintings of the ancients, though mere fragments, are yet sufficient to give us some idea of what was attempted and achieved in this line by the Greeks and Romans." Mr. Hilliard's opinion of the Pompeiian pictures was quoted, to the effect that "the drawing, expression and color are so good that we are inclined to overstate their excellence, in the same way as civilization is more than just to the poetry and eloquence of savage tribes." This comparison, the lecturer thought, hardly does justice to the real merits of these works of art. The Pompeiian painters belonged to a race of artists, and their productions are rather to be considered as inferior specimens of a grand art, which but for them would be almost unknown to us. They suggest an excellence which they fail to express. Their creators had not only superior knowledge and skill as artists, but were filled with genuine artistic feeling. The conception in their pictures invariably rises above the execution, and may be said to consist in vague reminiscences of the masterpieces of the old Greek world.

Proceeding next to consider the *technik* of these mural paintings, Mr. Spaulding gave a brief account of the theory formerly held that they were done in *distemper*, and of the abandonment of this theory since 1868, by reason of the patient and careful researches made by Herr Otto Downer, a German artist, who has spent considerable time in the examination of the old wall surfaces in the Pompeiian houses, and of the colors actually laid upon them. His conclusion that nearly all the pictures were painted in fine *fresco* (*i.e.*, with water colors laid upon the fresh and moist plaster), both in the ground colors and also in the figures and ornaments painted upon them, is now accepted by all competent critics. Overbeck, in the latest edition of his great work on Pompeii, acknowledges the error of the view which he had previously advocated, and declares that Downer has settled the question for all time. This is also Helbig's opinion, of whose valuable book on the Campananian wall-paintings Downer's treatise forms the preface. The secret of Downer's discovery lies in his finding out the radical difference between ancient and modern methods of preparing the wall surface for the painter to work upon. The old stucco was not only much thicker than that which is now used, but was also made of several layers of sand mortar and marble mortar, each one of which was put on before the layer underneath was dry. In this way a surface was prepared which would retain the moisture for a long period and enable the artist to continue his work on the same wall for several days. The fitness of the fresco, such as was practised at Pompeii, for rendering all the greater qualities of ideal art, has lately been dwelt upon with much force and earnestness by Professor Moody in his art lectures at the South Kensington Museum. The greatest artists have always been the greatest ornamentists. In proof of this it is only necessary to refer to the work of Michael Angelo in the Sistine Chapel, and that of Raphael in the Loggio and Stanze of the Vatican. We are, therefore, to think of those men of the old Roman world, who adorned the Pompeiian houses with such charming and varied compositions, as in every respect true artists. They lived, it is true, in a time when all art had fallen far below the divine heights which had been reached under the master-artists of ancient Greece, but they felt the constraining influence of grand artistic traditions.

The special topic of the lecture was then taken up, namely, the purely decorative and ornamental parts of these wall-paintings. These, the lecturer said, constitute an ideal world by itself, in which the fertile and capricious fancy of the artists had full play, creating artificial yet always pleasing realms, as delightful as any which the poet's mind calls into existence. Not only do we see "the light that never was on sea or land," but land and sea that never were are before us in all the charm of "something rich and strange."

This ornamental work was all done in free hand, the artists apparently inventing their *motives* as they went along. The wall was divided off into different sections, both vertically and horizontally, so that while the desired illusion is given of making the rooms appear both higher and longer than their real size, the mind of the spectator is satisfied by the simple unity of the general plan and the rich variety of the several parts.

By the aid of numerous plain views, the style of decoration found in the Pompeiian houses was very fully described, and afterwards by his colored representations the lecturer carried his hearers with him in imagination to the very rooms on whose walls these exquisite arabesques and fantastic architectural ornaments were painted.

BEETROOT SUGAR.

FEW Americans realize the possibilities of the sugar-beet culture. The manufacture of beetroot sugar is no experiment, for in Europe this industry is firmly established, last year's crop alone amounting to the enormous total of 1,000,320 tons, or nearly 65 per cent. of the entire consumption of sugar. The imports of foreign sugars into the United States last year exceeded six hundred thousand pounds, reporting a total value of $100,000,000. If a small percentage of the capital and energy that have been brought to bear on mining and transportation schemes in this country could be directed to this beet-sugar interest, in a few years the United States might produce all the sugar she requires for home consumption and have a surplus for export. We have the advantage of the experience of France and other European nations on this subject during the past one hundred years. The discovery that sugar was contained in beets was first made by Prussian chemists in the eighteenth century, but not until Napoleon I. lent this struggling industry the aid of his mighty power and prestige did it assume any material importance, and from a production in 1825 of 5,000 tons of beet-sugar France has increased her crop to over 350,000 tons in 1875. Nearly all the sugar used in France and Germany, and in fact throughout continental Europe, is from the beet, and even England, who has constantly opposed this culture on account of the possible effect on the trade of her West India colonies, took 110,000 tons of beet-sugar for refining purposes last year.

France employs in the beetroot sugar industry 80,000 laborers, twenty per cent. of whom are women and children, cultivating 340,000 acres of land, producing 6,000,000 tons of beets, equal to 350,000 tons of sugar, besides leaving 1,200,000 tons of pulp, an amount sufficient to feed 100,000 cattle or 1,200,000 sheep for a year, or to fatten three times that number during the winter, resulting in a product of more than 1,500,000 tons of valuable manure for future grain crops. These figures convey an idea of the mighty strides this great industry has made in Europe, and of the vast benefits that must accrue to all classes. European experience shows that the culture of beets rich in sugar can be profitably followed from the south of France to the North Sea; that all climates suit it; that it flourishes even in Russia, Norway and Sweden; that it is a remarkable fact that, while the cane improves by approach towards the equator, the beet secretes more sugar as its culture approaches northern latitudes; that the beet, as a sugar-producing plant, is for the temperate zone what the cane is for the torrid zone, though the former possesses many other desirable qualities aside from its saccharine properties, while the cane is alone valuable for its sugar; that beetroot sugar, taking into account its valuable auxiliary results, can be produced in the North cheaper than the cane sugar can be raised in the South; that an average of 2,200 pounds of sugar to the acre can be produced of beet sugar, while 1,800 pounds per acre is the average of West India plantations; that the pulp or refuse remaining after expressing the juice, amounting in weight to twenty per cent. of the whole crop, is fully equal, as palatable and nutritious cattle food, to one third the weight of the best hay; and, finally, that beetroot sugar is identical in every respect with the finest cane sugar, with no difference in color, taste, grain or crystal.

Millions of acres in the United States are as well adapted to the beetroot culture as the most famous sections of Europe; the fee simple in many of our good farming lands can be bought at a price not exceeding the cost of two or three years' rental of lands in France. The sugar beet is nearly identical with the mangel-wurzel, the culture of which is so common with us. Our beets, by careful chemical tests, contain as much sugar as European beets. The beet is destined to become the great sugar-producing plant of this country, because such vast territories are adapted to its growth, because it can be cultivated in healthy, temperate climates, because it can be manufactured in the centers of industrious and consuming populations, because capital would be more secure and more easily and cheaply obtained in the great belt of Northern States than in the Gulf States, or in the West Indies or South America.

Beet culture would be a profitable and beneficial crop, for it would involve deep plowing, heavy manuring, and thorough weeding, while the increased amount of manure secured from the cattle fed on the pulp, combined with the thorough culture, would put the land in splendid condition for raising wheat and corn, and go far towards settling the question of redeeming and improving the worn-out farms of our older States. The direct profit is large; for a crop of twelve or fifteen tons per acre, at a value of four to five dollars per ton, would pay better than any cash crop now raised, aside from the indirect advantages of cattle food, mellow and improved land for future crops. It would give employment to increased field labor during the summer culture, and in the manufacturing department during the winter months. It would supply a new branch of industry, establish new centers of trade, develop new fields for inventive skill, save millions of dollars to the country in foreign cost of sugar and transportation, and enhance the value of every farm in the vicinity of the factory. It is a subject of national importance; for, with a demand for two thousand tons of sugar a day from abroad, what would be our position in case of war with a maritime power? Imagine the increased prosperity if we could add to our annual national production even fifty million dollars' worth of sugar! It would induce superior methods of culture, better home markets, and greater prosperity for the masses.

The whole subject is well worthy the profound study of the political economist, the patient skill of the producer, the careful attention of the legislator, and the thorough investigation of the capitalist.—*Cultivator.*

BEET SUGAR IN MAINE.

TO GOVERNOR CONNOR and the Maine Legislature belongs the credit of making the first practical attempt to encourage the production of beet sugar in the Eastern States. In his inaugural address in 1876, Governor Connor urged the matter upon the Legislature, and enforced his public recommendation by presenting the subject to the citizens of the State generally, wherever he chanced to meet them. During the year he has given much attention to the investigation of the subject, and as the result has become fully confirmed in the opinion that the enterprise will prove a profitable one for Maine. In January he again presented the subject to the Legislature, and was able to show the subject in so favorable a light that the members of the Legislature of that State, who, although proverbially careful in voting away the dollars in the State treasury, were convinced that the subject is so important that they could afford to offer inducements to capitalists who would test the capability of Maine for the production of beet sugar. Accordingly, the Legislature has passed a measure authorizing the Governor and Council to offer persons who will take to Maine the machinery necessary for the production of beet sugar, for the purpose of manufacturing the same from beets grown in the State, a bonus of one cent a pound for all such sugar manufactured, and an additional bounty of $7,000 a year for ten years as a general encouragement. Beets grown in various parts of the State have been tested and have proved very rich in saccharine qualities.

WORK AND WAGES.

THE third of a series of four lectures on "Work and Wages," was lately delivered in the large theatre of King's College, London, by Professor Leone Levi. Mr. Anthony T. Mundella, M.P., presided.

Professor Leone Levi proceeded to discourse on "The Budgets of the Working Classes." His object was not to pry into matters which should be hidden from the public gaze, but rather to lay before his audience the importance and value of simply taking a good account of what we are actually receiving and actually spending during the whole of a year. The Budget was one of the most important events of the parliamentary session, but the Chancellor of the Exchequer had the national funds to draw upon, while the working man must see that his expenditure be moderate, legitimate, and under proper control. If this be a good practice for the State, would it not be well also for the family? We should consider whether our income is duly gathered and utilized, and whether our expenditure is rightly regulated. Merchants who did their business by checks possessed a ready means of calculating their expenditure. It was difficult to keep a diary, but he advised those present to get their wives to put down their expenses in a book, and that the gentlemen put down what they expended also. The pay of the laborer was in wages, and his income might also comprise the produce of any other industry exercised in spare hours, and the fruit of any money or property that any member of his family might have in building or trade societies. The wages might consist either in money or in kind, or in both, and when that was the case the money value of such articles and conveniences must be taken into account. A sailor might procure his sixty or seventy shillings a month, but it must be remembered that during his voyage he was lodged, fed, and boarded. The agricultural laborer might get eight, ten, twelve, or fifteen shillings a week, but in many parts of the country other things were included. A domestic servant got from ten to thirty pounds a year, but she also enjoyed board and lodging. The combination of payments in money and kind was sometimes not only indispensable, but might often be made advantageous to the laborer—though the truck system had been greatly abused. In order to make income and expenditure meet, a man must either increase his income or diminish his expenditure. It was very right to trust in Providence, but they must never forget the importance and duty of using rightful means. He advised them not to resort for support to the poor rates, which rates were most destructive to the honesty and self-respect of the laborer. What, again, was more disgraceful than for a man to resort to the parish doctor when he himself ought to be able to pay for such assistance! It was right that the rich should help the necessities of the poor, but it was for the working classes to say how long such compulsory charity should be allowed. The amount of charity in England over and above the poor law was far in excess of what was given abroad. Next, as to the question of expenditure. There was an old proverb which said, "Cut your coat according to your cloth." He would enjoin upon them under no circumstances to allow themselves to fall into debt, for it was a source of ruin. Above all, let them hate shop debts, for in resorting to them purchasers paid very high rates, and that because the tradesman had to take the chance of his debt never being paid. He would say, "Have the money before you spend it, and you will be sure to economize it to the very best." The expenditure of the working man's family did not differ very much from the expenditure of a person in the middle class of life, though the latter enjoyed more comforts and luxuries, for absolute wants usually consisted in such things as bread, flour, meat, potatoes, butter, sugar, milk, house-rent, fire and light, clothing, and education of children: these were the necessaries of life. There were the comforts of life which might be enjoyed in addition, such as newspapers, omnibus and railway fares, church expenditure, and some provision for the future. Whether an article was to be classed as a comfort or a luxury depended very much on the standard by which they were guided. It might be taken from statistics before him that 60 per cent. was required for food and moderate drink, 12 per cent. for rent and rates, 10 per cent. for clothing, 2 per cent. for fire and light, 1 per cent. for newspapers, omnibuses and traveling, 8 per cent. for church and charity, and 5 per cent. for saving. But this took no account of sickness and slack time, and it would only be fair that more economy should be made in certain of the items to meet unavoidable drawbacks. As a general rule, the necessities of life should be first provided; but he would advise them in any case to have something to save. It was right to be liberal, but preparation should be made for contingencies. Considerable economy might often be effected in daily expenditure by buying articles in other than the smallest quantities. He must also suggest that there was a great deal of waste in cooking. Another great item of waste arose from the amount spent in drink; but the reform must commence with ourselves. Let them not wait till they could make great efforts, but begin at once. Since Sir Robert Peel's Budget in 1842 nearly every step in reform in the Budget had been in reducing the taxation on necessaries of life, and rather enhancing it on luxuries. It was a lamentable result that when the working classes were receiving such an aggregate of wages their savings should be so small, for a very large portion of the moneys in the savings and Post Office banks belonged to the middle classes. In discussing the question of the budget of the working classes, it would be wrong to ignore the number of cases of unmistakable hardship; and that there was great heroism to be found among the poor in their charity to their relatives and friends. In conclusion he would say, "If you would maintain yourselves in comfort, honor, and self-dependence, look to your budget, and endeavor so to economize your income that you may have enough and to spare."

PHYSIOLOGY.

The Controversy on Spontaneous Generation.—Dr. Bastian having asserted that bacteria are generated *de novo* in sterilized urine, when this is rendered neutral by the addition of *liquor potassæ* and kept at a temperature of 115°–122° F., M. Pasteur, by merely substituting solid caustic potash for the solution, prevented any living organisms from making their appearance in the neutral or feebly alkaline urine. To this Dr. Bastian rejoined that the failure of his experiment in Pasteur's hands might be accounted for by a larger proportion of potash having been added to the urine than was required for its exact neutralization. The question has been subjected to a renewed investigation by MM. Pasteur and Joubert (*Comptes Rendus*, January 8, 1877), with a view to ascertain how far this objection may be valid. They now find: first, that no living organisms make their appearance even when the quantity of solid caustic potash added to the boiled urine is just sufficient to its exact neutralization; secondly, that the presence of potash in sensible excess, rendering the liquid decidedly alkaline, does not militate against the success of Dr. Bastian's experiment, provided it has been added in solution, and not in the solid form. Dr. W. Roberts and Professor Tyndall have arrived, on independent grounds, at exactly the same conclusions as M. Pasteur (*Proceedings of the Royal Society*, December 21, 1876). They prove that the evolution of organisms in the alkalized urine is simply due to the introduction of germs contained in the *liquor potassæ*. It has been shown—by M. Pasteur many years ago, by Dr. Roberts more recently—that alkaline liquids are less easily sterilized by heat than acid ones; though the nature of the protective influence exerted on germs by an alkaline medium is still a mystery. Exposure to the temperature of boiling water does not destroy bacterial germs suspended in a solution of potash. When the solution is kept in an oil-bath at 280° F. for fifteen minutes (Roberts), or even at a temperature of 230° F. for the same length of time (Tyndall), it completely sterilizes, and may then be added to boiled urine without any risk of setting up putrefactive changes, or ministering to the "spontaneous" development of life.

Physiological Properties of Hydrobromic Ether.—This colorless liquid, intermediate in density and boiling-point between chloroform and ordinary sulphuric ether, has lately been studied by M. Rabuteau (*Comptes Rendus*, December 27, 1876). When administered to animals by way of inhalation, it brings on insensibility more speedily and more completely than chloroform; moreover, the animal regains its consciousness more quickly, after the inhalation is stopped. Hydrobromic ether is quite free from the caustic and irritating properties of chloroform. When given by the mouth (in a dose of from one to two grammes) it does not induce anæsthesia, though it appears to soothe pain and tranquillize the nervous system without interfering with the appetite or other functions. In whatever way the ether may have been administered, its elimination always takes place through the lungs. It does not appear to undergo any decomposition in the system, a mere trace of bromine being found in the urine after large quantities of the ether have been inhaled.

On the Vaso-motor Nerves of Striated Muscle.—It has been known for some years that when a voluntary muscle is thrown into a state of contraction, the flow of blood through its tissue is simultaneously augmented, notwithstanding the resistance offered to it by the compression of the intramuscular blood-vessels. The physiological demand for an increased supply of nutrient matter and greater facilities for getting rid of waste products, manages in some way or other, to overcome the obstacles in the way of its fulfilment. The mechanism of the process has lately been studied by Mr. Gaskell (*Proceedings of Royal Society*, December 14, 1876), in the mylohyoid muscle of the frog. When this muscle is placed under the microscope, the circulation through it is seen to present much the same character as in the web. But when the muscle is directly stimulated by an interrupted current, the phenomena produced are exactly contrary to those observed in the web under similar conditions. In the former case, the small arteries dilate; in the latter, they undergo a marked constriction. When the motor nerve-trunk of the mylo hyoid is subjected to mechanical or chemical irritation, the arteries undergo considerable and rapid dilatation after a brief pause, during which no sign of transient constriction can be detected. Analogous phenomena are witnessed when the muscle is thrown into a state of decided tetanus by stimulating the peripheral end of its nerve with a fairly strong interrupted current. The arterial dilatation likewise ensues on electrical stimulation of the motor nerve when the muscle has been completely paralyzed by curare. The action of this drug appears to be limited to the motor nerve-ends, not involving the vaso-motor fibres associated with them. After strong stimulation of the nerve trunk, the period of vascular dilatation is followed by a period of constriction; just as strong stimulation of the sciatic invariably causes a primary constriction, and subsequent dilatation, of the vessels in the web. Dilatation was also noticed to occur even when the pressure in the interior of the vessels had been rendered very feeble by compressing the aorta; under those circumstances, a reflux of blood took place from the veins. Mr Gaskell failed to induce reflex dilatation of the intra-muscular blood-vessels by stimulating centripetal nerve-fibres. He also found that atrophia, in doses sufficient to arrest the inhibitory power of the vagus, did not in any way impair the action of the motor nerve on the vessels of the mylo hyoid.

Electrical Excitability of the Cerebral Hemispheres in the Frog.—Langendorff states that stimulation of certain regions of the cerebral hemispheres in the frog is invariably followed by muscular movements (*Centralblatt für die Med. Wiss.* 53, 1876). These movements are bilateral when both hemispheres are excited simultaneously; when only one is excited, the movements are limited to the opposite side of the body. The "irritable zone" is situated in the parietal region; when other parts of the cerebrum are stimulated with *weak* currents, or when the hemispheres have been completely separated from the centres lying behind them, no movements take place. The effects of electrical excitation are prevented by ether-narcosis, but not by removal of all the blood from the body. The phenomena produced by direct electrization of the brain may be exactly imitated by applying the electrodes to a particular spot on the surface of the skull, between the eye and the tympanic membrane.

Influence of the Nervous System on Perspiration.—The activity of the sudoriparous glands was for a long time believed to stand in some immediate relation to the degree of hyperaemia, active or passive, of the skin, and to be, in some measure, under the control of the vaso-motor nerves. Certain phenomena, however, resulting from disease and from the action of such poisons as atrophia and pilocarpine, are incompatible with this view, and point rather to the existence of a more complicated and independent nervous mechanism, analogous to that which has been demonstrated in connection with the salivary glands. Luchsinger has succeeded in throwing some light on the subject by experiments performed on young cats, the hairless parts of whose hind paws may readily be made to perspire (*Pflüger's Archiv*, xiv. 8 and 9). He finds that electrical stimulation of the sciatic is always followed by the appearance of drops of sweat on the toes of the corresponding paw. This is not due to mere expulsion of liquid previously contained in the follicles; it is a true secretion, which may be renewed again and again by repeating the stimulation of the nerve. If one sciatic be divided, and the animal placed in a warm chamber, the uninjured extremities perspire freely, while the toes of the paralyzed limb continue dry; even ligature of the iliac vein on the same side, while increasing passive congestion to its utmost, does not avail to cause sweating. These and similar experiments prove that the secretion of sweat, like that of saliva, is under the control of special secretory nerve-fibres, and independent of those which regulate the calibre of the blood-vessels. The fibres in question are contained in the sciatic trunk, which derives them from the abdominal cord of the sympathetic. Luchsinger has succeeded in tracing them back, through *rami communicantes*, to the anterior nerve-roots in the lumbar and lower dorsal regions of the spinal cord. They are connected with special centers, situated in the cord itself. These centers may be excited either by psychical impulses conveyed downwards from the brain, or by contact with over-heated or poisoned blood (blood loaded with carbonic acid or containing certain poisons, such as nicotine), or, lastly, by impulses conveyed to them from the periphery along centripetal fibres. The occurrence of reflex sweating is illustrated by the curious case of a healthy man in whom copious perspiration, limited to the face, could always be brought on by touching the tongue with vinegar or pepper.—*Academy.*

TREATMENT OF RINGWORM BY LEAVES OF CASSIA ALATA.

BY DAVID FOULIS, M.D.

WHEN resident in India (Cachar) many years ago, I had numerous opportunities of observing a form of vesicular ringworm which afflicted both natives and Europeans. It commenced by a minute cluster of vesicles on the skin soon extending in the form of a ring, or segment of a ring, the center being left free; it was very itchy, and the scratching which this induced left the little vesicles torn, and the surface raw and weeping, or else covered with scabs. Not a few of tea-planters of the district caught the disease; and they resorted to various remedies, the favorite one being the ointment of the red iodide of mercury, applied so as to blister the skin. This gave a temporary relief at the cost of a good deal of suffering, especially if the surface affected were large. But none of the remedies in use there could at all compare for efficacy with the native remedy. This consisted in the fresh leaves of the *Cassia alata*, called in Hindostanee the "dood patta." A few of the leaves were taken and vigorously rubbed over the diseased area until the leaves were torn to fritters; the expressed juice was left to dry on the skin, which it stained for a time of a light brown color. The effect invariably was, that the itching at once disappeared, and that in a day or two the skin was restored to its normal healthy aspect. The process of rubbing was by no means painful; on the contrary, the patients seemed rather to feel an indefinite pleasure from it. So useful did I find this remedy, that I procured some cuttings of the plant, and planted them in the vicinity of my bungalow; and many a time have I had the pleasure of relieving those suffering from this annoying disease by the gift of a handful or two of these leaves.

I may mention, by the way, that the imported coolies in the tea gardens did not suffer so much from the ringworm as the native Cachar villagers. I remember treating one of the latter, whose whole body was covered with it; and few applications of the leaf effected a cure, which I believe was permanent.

It would be interesting to learn whether the Goa powder, recommended by Sir J. Fayrer, contains these leaves in any form; and also, whether their active principle had any affinity with the chyrsophanic acid which Mr. Squire finds so useful in psoriasis. The *Cassia alata* belongs to the same genus as the senna plant, and experiment might reveal some analogy in their therapeutic actions; but I am not aware of any trials of the leaves having been made except as a remedy for ringworm.—*British Medical Journal.*

VARIATIONS IN THE NUMBER OF WHITE BLOOD GLOBULES IN CERTAIN MALADIES.

DR. HENRI BONNE, of Paris, has been convinced by his researches that there is a constant relation between the production of pus and the presence of an excess of white globules in the blood. Thus, during the evolution of an abscess, there is an excess of the white globules in the blood, but as soon as exit is given to the pus, this excess disappears. In the same way, the white corpuscles are found in excess when a suppurating wound exists. In all the internal febrile maladies, the period of leucocytosis does not seem to correspond to the time of the highest temperature, but to the formation of pus in the organism; thus in typhoid fever, the increase of the white corpuscles is observed at the outset of the disease and at the commencement of convalescence, and in pneumonia it is observed only at the period of hepatization. Dr. Bonne has also observed an evident relation between the eruption of a group of herpes vesicles and the number of white globules, the latter diminishing when the eruption appeared. The lochial discharge after parturition, and leucorrhœal discharges, are also accompanied by a diminution of the leucocytes. Dr. Bonne publishes thirteen observations, each of them being accompanied by a chart representing the variations in the number of white globules at different periods of the disease.—*Le Progrès Médical.*

THE PHOTO-LITHO. OIL PAINTING OR CHROMOTYPE.

MR. I. M. VAN WAGNER gives the following in *Anthony's Photographic Bulletin:*

Take an unmounted print, wet it, and brush over a solution of isinglass made in the proportion of one teaspoonful to half a cup of water; lay it on the glass and rub out all air bubbles (the same as you would to make an old ivorytype), and let it dry. Now fill the glass that your plate is on with castor oil, letting it stand until it is perfectly transparent, which will take from three to twelve hours, according to the paper the photograph is on. When transparent rub off all the oil from the picture, which is ready for painting. Now color the eyes from behind the photo, and then lay it on a piece of white paper to see if you have the right shades (use a retouching frame to color the photograph on); next the hair, very lightly, then the jewelry; also all the whites that you wish to make resemble lace or white work. Now put over the photograph, on the back, a second convex glass, and fasten the edges with sticking paper; now mix the flesh color and paint all over the face. Then paint over the hair, to make it the shade desired. Next comes the drapery, paint it over the same as you would the face, and you can get as beautiful, soft, and rich color as you desire. When painted, back with white cardboard.

A QUICK PHOTO BATH.

THE *Archiv* publishes a communication from Mr. Conrad Petersen, now resident at Fayeth county, Texas, in reference to rapid exposures.

A silver bath to sensitize plates, requiring but a third the usual exposure, may be prepared, says Mr. Petersen, as under:

Nitrate of silver	8 ounces.
Iodide of potassium	40 grains.
Nitrate of baryta	288 "
Pure distilled water	96 ounces.

The bath is filtered, and a little nitric acid is added to make it work clear.

The collodion employed is made from "Anthony's snowy cotton," washed in water containing a few drops of ammonia; it is rinsed afterwards in pure water, pressed in a cloth, and allowed to dry in the sun, so that no trace of ammonia remains behind. To each ounce of ether and alcohol mixture I take five grains of this pyroxiline.

The iodizing solution for an ounce of normal collodion is prepared of:

Iodide of ammonium	3 grains
Bromide of cadmium	1½ "
Iodide of cadmium	2 "
Bromide of potassium	1½ "

These salts are rubbed down in a dry mortar and dissolved in alcohol. The developer is composed of:

Double sulphate of iron ammonium	3½ ounces.
White sugar	320 grains.
Glacial acetic acid	1½ "
Rainwater	10 ounces.

Before use there is mixed with every three ounces of this developer twelve ounces of rainwater and one ounce glacial acetic acid.

THE CHEMICAL CONSTITUTION OF GUN COTTON.

SOME recent investigations made by MM. Champion et Pellet, upon the composition of pyroxyline, will not be without interest to photographers. Many have stated, and Professor Abel of Woolwich among the number, that the difference between the most explosive form of gun cotton and that employed for making collodion consists in the former containing more nitrogen than the latter. Military and blasting gun cotton, according to Mr. Abel, contains three atoms of nitrogen, and may therefore be aptly termed tri-nitro-cellulose; while the most soluble cotton, that chemist avers, contains but two atoms. The latter is almost completely soluble in a solution of alcohol and ether, and hence it constitutes a capital pyroxyline for photographic purposes. MM. Champion et Pellet, whose names are well-known as authorities on explosives, have lately analyzed military gun cotton, and do not seem to be quite in accord with Mr. Abel. Instead of containing three atoms of nitrogen, they make it out that the compressed Abel cotton has but two and a half atoms, and they further state that this is the composition of several very good photographic cottons, which they have also examined. Thus, the Russian gun cotton of M. Carette, which possesses exceptional qualities as a constituent of photographic collodion, these gentlemen state, contains quite as much nitrogen as the military explosive manufactured by the Stowmarket Gun Cotton Works, according to Mr. Abel's patent. Some gun cottons which the experimenters have themselves prepared also give these results on analyzing, but it is different with a paper pyroxyline which was examined, and which, as we know, makes very good collodion. This, MM. Champion et Pellet admit, contains but two atoms of nitrogen against the two and a half found in cottons proper. The inexplicable part of the matter is therefore apparently this: That they show that two pyroxylines may be perfectly soluble, and yet be differently constituted; to wit, the Carette gun cotton and paper pyroxyline. The ordinary military gun cotton in this country should not have more than twelve per cent. of its mass soluble; and, if this is the case, it is, indeed, pronounced unfit as an explosive. Yet again, MM. Champion et Pellet affirm that this military and insoluble gun cotton is of the same chemical constitution as perfectly soluble or photographic gun cotton. There is something here that needs further experiment and explanation, for one can scarcely believe that the soluble and insoluble material have the same composition. One explanation of the discrepancies between the analysis of Prof. Abel and that of MM. Champion et Pellet, which strikes us as possibly being a key to the solution, may be the circumstance that the French chemists have not obtained a good specimen of the military gun cotton manufactured in this country. As the material sells for two or three shillings a pound, it is necessarily very roughly prepared, and cannot be regarded in any way, in respect to chemical purity, as equal to that which chemists and photographers carefully prepare in their laboratories. This commercial product not unfrequently, it may be presumed, contains a goodly proportion of unconverted cotton, and, if this is the case, the amount of carbon found upon analysis would necessarily be much higher, and the percentage of nitrogen less. Probably Mr. Abel's analysis was based upon a very pure product, carefully prepared under his own superintendence; and, if so, there is ample ground for supposing that an examination of such gun cotton, and the material manufactured in large quantities at Stowmarket, would give different results. One thing, however, is certain, that the subject cannot now remain as it is. The names of MM. Champion and Pellet are too well known to question the soundness of their work, while the reputation of the President of the Chemical Society is also beyond suspicion. We shall look with interest, therefore, for any explanation that can satisfactorily reconcile the analytical results of these gentlemen.—*Photo. News.*

[THE ACADEMY.]

PROFESSOR POGGENDORFF.

By Walter Flight.

By the death of Professor Poggendorff, of Berlin, the world has lost a man whose name is deservedly famous in every land where science is pursued.

Johann Christian Poggendorff, a native of Hamburg, was born on December 29, 1796, and lived to the advanced age of eighty-one years. He was a son of a successful merchant of that city. Having in his earliest years no inclination to adopt his father's calling, and feeling a desire to pursue science, he devoted himself to the study of pharmacy. After some time, however, he relinquished this line of action, and in 1820 entered the University of Berlin as a student. In the succeeding year his first scientific contribution appeared, it being a paper published in Oken's journal *Isis*, and entitled: "Physisch-chemische Untersuchugen zur näheren Kenntniss des Magnetismus der Volta'schen Säule." This was followed in 1826 by "Ein Vorschlag zum Messen der magnetischen Abweichung," when he devised the instrument to which Gauss, at a later date, gave the name of the magnetometer (see C. F. Gauss, *Intensitas vis magneticae terrestris ad mensuram absolutam revocata*, 1832). In the year 1834 he was called to the Chair of Physics in the University of Berlin.

Poggendorff's researches led him into varied fields of work, but in none with so much success as in that of physics, and in his later years his attention was almost entirely devoted to the study of voltaic electricity. Among his investigations may be mentioned the inquiry into the quantitative determination of electro-motive force, the devising methods for the estimation of the maximum strength of two voltaic currents, an examination of the phenomena of galvanic polarization, the construction of a commutator—so happily referred to in Prof. Scheerer's poem on the jubilee day (*see infra*)—the determination of the resistance of liquids to the passage of electricity, the development of heat by electric currents diamagnetic polarity, and the devising of new means of intensifying induction currents. In his earlier years he also examined the boiling-points of saturated solutions, and some years later wrote a memoir on the determination of the density of vapors. He critically examined the instruments employed for the estimation of the intensity of light, and investigated interference phenomena. Even meteorological questions were not beyond his range, and we find him discussing the fluctuations of the barometer, rain, parhelia, and star showers. Among the chemical questions which he attacked were the preparation of bromine from salt-springs, new modes of preparing formic acid, the preparation of sodium bicarbonate, the nature of the compounds of aluminium, and the existence of the hydrides of silver, and of other metals. And, lastly, in the branch of mineralogy Poggendorff examined the composition of the felspars and other mineral species allied to them, the nature of graphite, etc.

In addition to these numerous and important investigations, Prof. Poggendorff's labors in the field of literature were of vast extent. We find him, in 1837, allied with Liebig in editing the classical *Handwörterbuch der reinen und angewandten Chemie.* His connection with this publication ceased after the issue of the first volume. In 1853 he published his *Lebenslinien zur Geschichte der exacten Wissenschaften*, a forerunner and sketch of the great work which came ten years later, the invaluable *Biographisch-litterarisches Handwörterbuch zur Geschichte der exacten Wissenschaften* in two volumes. Now that fourteen years have elapsed since its publication, a supplementary volume is urgently required, although the want may to some extent be supplied when the Royal Society issue the additional volumes of their "Catalogue of Scientific papers (1800–1863)."

In the spring of 1824, soon after the death of Prof. Gilbert, of Leipzig, who had edited the *Annalen der Physik* bearing his name since 1799, Barth, the publisher of that famous serial, learned that Poggendorff had matured a plan for producing a journal devoted to physics and chemistry. To increase the already numerous channels for scientific publication by the foundation of a new serial appeared injurious alike to science and to private interests, and negotiations between editor and publisher resulted in the merging of Gilbert's *Annalen* in the new venture, of which Poggendorff held the management with such signal success for more than half a century. Mitscherlich and Heinrich Rose, among chemists, Erman and Seebeck, among physicists, as well as Fr. Hofmann, Von Buch, and A. von Humboldt, gave it their warmest support; Berzelius, Arfvedson, and Bonsdorff, promised to send the results of their labors to the *Annalen;* and through Humboldt's aid and co-operation of the *savans* of Paris, through Gustave Rose's that of the best scientific workers in London and Edinburgh, was secured. The *Annalen der Physik und Chemie*, as the new serial was named, while mainly devoted to the publication of researches in the branches of science referred to in the title was, according to an announcement in the first part, to deal also with such allied subjects as meteorology and what is now called physiography, and while pure mathematics was not considered to come within the area of the editor's labors, that branch of study would yet find a place in the *Annalen*, in so far as it tended to illustrate chemistry and physics. Some notion of the completeness with which during the five decades the works of the leaders of science have been recorded in the *Annalen* may be gained by an inspection of the following short list of the number of papers of some of the more distinguished contributors:

Berzelius	112	Ramelsberg	177
Brewster	67	Vom Rath	71
Dove	104	Riess	84
Faraday	76	Gustav Rose	100
Haidinger	90	Heinrich Rose	193
Heintz	60	Scheerer	57
Liebig	56	R. Schneider	50
Magnus	65	Schönbein	88
Poggendorff	152	Wöhler	65

The translation of Regnault's memoirs alone occupies 696 pages, and the notices of the researches of Faraday cover 1,617 pages. After Poggendorff had filled the editorial chair for half a century, and 150 volumes of the *Annalen*, as well as some supplementary volumes, had appeared, more than sixty of his friends determined that the time had come to do honor to such vast labor and such unflagging care by themselves contributing to and editing a special jubilee volume of the journal, which appeared in February, 1774; it bears on the title page the words: "Jubelband dem Herausgeber J. C. Poggendorff zur Feier fünfzigjährigen Wirkens gewidmet," and contains an excellent likeness of their revered chief. He lived to direct the publication of but a few more volumes, and must have died about the time that the first part of the newly projected *Beiblätter zu den Annalen*, to which we referred some weeks ago, passed through the press.

A COMBAT WITH AN INFECTIVE ATMOSPHERE.*

By John Tyndall, F.R.S., Professor of Natural Philosophy.

A year ago I had the honor of bringing before the members of the Royal Institution some account of an investigation in which an attempt was made to show that the power of atmospheric air to develop life in organic infusions—infusions, for instance, extracted from meat or vegetables—and its powers to scatter light went hand in hand. I then endeavored to show you that atmospheric air, when left to itself, exercised a power of self-purification; that the dust and floating matter that we ordinarily see in it disappeared when the air was left perfectly tranquil; and that when the air had thus purified itself, the power of scattering light and the power of generating life disappeared together. For the sake of reminding you of this matter, we will now cause a beam of the lamp to pass through the air. You see the track of the beam vividly in the air. You know that the visibility of the track is not due to the air itself. If the floating matter were removed from the air, you would not be able to track the beam through the room at all. You see the track in consequence of the floating dust suspended in the air. If the air be inclosed in a place free from agitation the dust subsides, and then, as I endeavored to show you a year ago, the air possesses no power of generating life in organic infusions. The nature of the argument is this: You see the dust as plainly as if it were placed upon your hand and you could feel it with your fingers. You found that the dust, when it sowed itself in organic infusions, produced a definite crop in those infusions; and you are equally justified in inferring that the crop thus produced is due to the germs in the dust, as a gardener would be in believing that a certain crop is produced from the seeds which he sows. I say that the inference that his crop is the product of the seeds that he sows is not more certain than the inference that those crops produced in the organic infusions are due to the seeds contained in them.

You know the method that we resorted to for the purpose of enabling us to get rid of this dust. The object was to allow the air to purify itself, and it was done in this way: I have here the first chamber that was used in these experiments. You see at the bottom a series of test tubes entering the chamber: they are air-tight, and they open into it. There are windows at the sides, and here is a pipette through which the liquids can be introduced. Behind we have a door which opens upon its hinges. Now, imagine this perfectly closed; imagine it abandoned entirely to itself, left perfectly quiet. In a few days the floating dust of the air contained in the chamber entirely disappears; it has removed itself by its own subsidence; and then when you send a beam of light, such as we have here through these windows, you see no track of the beam within the chamber. When the air is in this condition, you pour through this pipette infusions of beef, mutton, or vegetables into these tubes, and allow them to be acted upon by the air. Last year, between fifty and sixty of these chambers were constructed, and the invariable result was that these infusions never putrefied, never showed any change, were perfectly sweet months after they were placed there, as long as the air had this floating matter removed. You had nothing to do but to open the back door and allow the dust-laden air to enter the chamber to cause these infusions to fall into a state of putrefaction, and swarm with microscopic life, in three days after opening the door. I have a smaller chamber here—for we use chambers of different sizes—and it will enable you to understand our exact process. You see here the stand on which the chamber rests. There are two bent tubes that communicate with the outer atmosphere, for I wish to have a free communication between the air outside and the air within. You see the pipette through which the tube is filled. When the infusion is poured in, you place it in an oil-bath contained in a copper vessel, such as we have here, in which you boil it for five minutes. Now, that boiling for five minutes was found capable of sterilizing every germ contained in the infusions placed in these chambers. This year our experiments began by a continuation of those that we made last year. In order to enable you to judge of the severity of the results obtained last year, I have here five cases belonging to the experiments then made. You will see that the infusions are vastly concentrated because of their slow evaporation. The quantity of liquid is reduced to one-fifth of its primitive volume, but this one-fifth is as clear as rock crystal; whereas, the tubes exposed to the ordinary air outside fell long ago into utter putrefaction. They became turbid and covered with scum; and when you examine these infusions to ascertain the cause of that turbidity, you find it to be produced by swarms of small active organisms.

This year our inquiries began in the month of September. But we will pass over these inquiries for the moment and go to those of October. On October 29th, two members of the Royal Institution collected a quantity of fungi in Heathfield Park, Sussex. These were brought to London on the 30th. They were placed for three hours in warm water, and whatever juices they possessed were thus extracted from them. They were placed in chambers and digested separately. There were three kinds of fungi; we will call them red, yellow and black. Now, I confess that, thinking I had secured a perfect freedom from any invasion of those contaminating organisms that produce putrefaction, I expected that we should find that these infusions of fungus would maintain themselves perfectly clear. To my surprise, in three days the whole of them broke down; they became turbid, and covered by a peculiar fatty, deeply indented, corrugated scum. Well, that was a result not expected, but I pursued the matter further. I got another supply of fungi. Even in this first experiment, I had adopted care at least as great as that which I adopted last year, and which led to a perfect immunity from the invasion of putrefaction. With the fresh supply of fungi, I operated with still more scrupulous care. The infusions were placed as before in three chambers. In one of these the infusion remained perfectly pellucid; there was no trace of any organism to be seen. In each of the other chambers one of the three tubes gave way. Each chamber contained three tubes; so that out of nine tubes containing an infusion of fungus seven proved to be intact, entirely uninvaded. Therefore, whatever argument or presumption was raised by the first chamber in regard to the idea that life was spontaneously generated in it, was entirely destroyed by the deportment of the other chambers. Seven out of the nine remaining intact was sufficient to show that it was some defect in the experiment that caused the first chambers to give way so utterly. I continued the experiments, and inasmuch as fungi disappeared on the approach of winter, other substances were chosen. I took cucumber and beetroot, having special theoretical reasons for doing so, and prepared infusions of them with the aid of my excellent assistant, Mr. Cotterell. We placed these in our chambers as before, boiled them for five minutes, and abandoned them for what I supposed to be moteless air within. Again, to my surprise, an infusion of beetroot in one chamber, and an infusion of cucumber in another, broke down. All the tubes became turbid and covered with this peculiar fatty scum. Other chambers were then tried. I had begun to suspect that we were operating in contaminated atmosphere; that my infusions were in the midst of a pestilence which it was hardly possible to avoid. The consequence was, that I withdrew the preparation of the infusions from the laboratory downstairs, and I went to one of the highest rooms in the Royal Institution, had the infusions prepared there, and introduced into the cases, which were afterwards boiled in the laboratory below. There were a great number of these cases. The substances chosen were cucumber, beetroot, turnip, and parsnip. Great care was taken to have the infusions properly prepared, and to have them rendered as clear as possible. To give you an idea of the care taken, I may mention that the infusions of turnip and beetroot were passed through twenty-four layers of filtering paper, and were thereby rendered clear; that the infusion of cucumber was passed through one hundred and twenty layers of filtering paper, and thereby rendered clear; and that the infusion of parsnip was passed through three hundred layers of filtering paper, and it was still opalescent. The suspended particles were so small that the filtered paper had no power whatever to arrest them, and the finest microscope ever made would have proved powerless to exhibit the individual particles that produced this opalescence. Notwithstanding all this care, the chambers containing these infusions in three days became filled with bacterial life. They were turbid, covered with scum, and showed all evidences of putrefaction. This was on November 20th. On November 25th, we went upstairs and prepared another chamber, or a series of chambers. When the tubes containing the infusions were placed in the oil-bath, the liquids within the tubes opening into the case of course boiled, steam was discharged into the case, the air of the case being thereby rendered warm. It was found that on the cessation of the ebullition, although the pipette was immediately plugged with cotton-wool, and the bent tubes also plugged with cotton-wool, still, in consequence of the contraction of the air within, there was a considerable indraught. Last year, we found invariably that the interposition of the cotton-wool entirely sifted this entering air so as to arrest any germs of seed that it might contain. I thought, however, in this case, that the germs might be carried in by the suction when the air of the chamber contracted. In the former case, we operated after having filled the chamber with the infusion, and boiled it in the laboratory; in this case, we took the additional precaution of boiling the infusion upstairs, and taking care that it was properly plugged with cotton-wool. But here, again, notwithstanding this augmented care, the infusion utterly gave way, and showed those evidences of life that had distracted me previously. When I say distracted, it is not meant that I was in the least degree daunted or perplexed about it. I knew perfectly well that the matter would be probed by and by.

On November 27th, a new chamber was constructed containing cucumber and turnip. Particular care was taken with the stopping of the pipette, and also the bent tubes opening into the atmosphere. In one instance, about this time, it was noticed that the infusions in the tubes within the chamber opening into the moteless air, or at least what I supposed to be the moteless air, fell more rapidly into a state of putrefaction, became more rapidly covered with scum, than the tubes exposed in the air outside. When the tubes containing precisely the same infusion were exposed to the air outside they were perfectly clear, while those within were turbid and covered with scum. This brought to my mind an experiment made the previous year with trays placed one above the other. It was found that, when two trays were placed one above the other, although the upper tray had the whole air of the room for its germs to deposit themselves, the under tray was always in advance of the upper in the development of life. The reason was simply this: The air in the under tray was less agitated, and this floating matter had time slowly to sink in the infusions. There was no other solution possible than that, by some means or other, the germs had insinuated themselves into my chamber, and that these germs, sinking slowly through the unagitated air of the chamber, were able to produce the effect within, in advance of the effect produced upon the openly exposed tubes without. On November 27th, I had a similar case, and also on November 30th, and on December 1st. The chambers were prepared and filled with all care, and yet the infusions broke down, became turbid, and were covered with scum. I then had a number of tubes filled with infusions, and sealed them hermetically. They were exposed in an oil-bath, and heated for a quarter of an hour to a temperature of 230° F., for I wanted to see whether these effects were due to any germs of life in the infusions themselves. This superheated cucumber infusion was introduced into the chamber, and it was found that the superheating of the infusion did not even retard the development of life. In two days, every tube of the chamber was swarming with bacteria. I then passed on to another system of experiment pursued last year; that is, the exposure of the infusions to air calcined by passing a voltaic current through platinum wire, so as to raise the wire to a state of incandescence. Such arrangements are here. We have underneath this shade two wires, and stretching from wire to wire we have a spiral of platinum. Passing a voltaic current through the spiral, it was found last year that five minutes of incandescence were sufficient entirely to sterilize and destroy all germs contained in this air, and to protect the infusions underneath from all contamination; the time of incandescence was doubled this year. The wire was raised as close to the point of fusion as possible; still, notwithstanding all this additional care, the infusions one and all gave way. I thought that there might be some defect in the construction of the apparatus.

Here, you see, is an old broken apparatus containing infusions that have remained perfectly good since last year; but great pains were taken in having the apparatus of the most improved form. Still, notwithstanding all my efforts, the infusions broke down and became swarming with life. My attention was now very keenly arrested, and on December 1st I scrutinized more closely than ever I had done previously the entry of the infusions through the pipette tube into the tubes opening into the chamber, and I noticed, at all events, a danger of minute air-bubbles being carried down along with the descending infusion. That caused me to adopt another mode of experiment; but, previously to this, I fell back upon some of the infusions found so easy to sterilize the previous

* A lecture delivered at the Royal Institution, January 19, 1877. From the *British Medical Journal*.

year. I operated upon beef, mutton, pork, and herring infusions, and found that even such infusions, which with ordinary care were completely sterilized last year, and are preserved to the present hour intact like the others, all gave way.

How, then, are we to look at these things? Here are results totally different from those that we obtained last year. You may ask me, perhaps, "Why do you not loyally bow to the logic of facts and accept the conclusion to which those experiments apparently so clearly point? Why do you not regard them as a demonstration of the doctrine of spontaneous generation? Is there any other way of accounting for it than by a reference to this doctrine?" You may ask whether I was held back by prejudice from accepting this conclusion; whether I was held back by a love of consistency or by the fear of being turned into ridicule and sneered at by those whom I ventured to oppose on a former occasion. Ladies and gentlemen, there is a title which I believe, as the generations pass, will, if the owners of the title are true to themselves, become more and more a title of honor—that is, the title of a man of science; and of that title I should be utterly unworthy were I not prepared to trample all influences and motives such as those mentioned under foot, and were I not ready, did I conceive myself to be in error in what was brought before you last year, to avow here frankly and fully in your presence that error. I should be unworthy the title of a scientific man if my spirit had not been brought into this state of discipline as to be able to make such an avowal. Why, then, do I not accept those results as proving the doctrine of spontaneous generation? The celebrated argument of Hume comes into play here. When I looked into all my antecedent experience, and into the experience of other men for whom I have the greatest esteem as investigators, it was more easy for me to believe the error of my manipulation, to believe that I had adopted defective modes of experiment, than to believe that all this antecedent experience was untrue. It was my own work that was thus brought to the bar of judgment, and my conclusion was, that I was far more likely to be in error than that the great amount of evidence already brought to bear upon the subject should be invalid and futile. Hence, instead of jumping to the conclusion that these were cases of spontaneous generation, I simply redoubled my efforts to exclude every possible cause of external contamination. This was done by means of doing away with the pipette altogether, and using what we call a separation funnel. Here you have a chamber with a pipette entering. This pipette tube has not a bulb or mouth such as you have here; it is simply closed by a tube of india rubber, and that again is closed by pinchcock. Now, here we have an infusion of hay. At present, this stop-cock stops it. I turn it on, it goes down; I turn it off, and this liquid column is now held by atmospheric pressure. This was introduced into the india rubber tube, the india rubber tube being first filled with the infusion, so that no bubble of air could get in. When the separation funnel was placed thus, and the cock was turned on, the liquid was introduced into the chamber without an associated air-bubble. Mr. Cotterell will show you the result of this severe experiment. Here is an infusion of cucumber, the most refractory of all infusions that I have dealt with. It was prepared on December 8th, 1876, so that it is between six and seven weeks old. Two days were sufficient to break down this infusion when contamination attacked it; but, by this more severe experiment, it is enabled to maintain itself as clear as crystal, although it has been there for six or seven weeks. You will see by the light behind that it is, as I have described it, perfectly clear. You will observe that the infusion is diminished by evaporation, but it is as clear as distilled water, and there it remains as the result of this severe experiment.

Let us now ask how it is that these curious results that I have brought before you were possible; how is it that the results of this year differ so much from those obtained previously. The investigation of this point is worthy of your gravest attention. I am now called back to the experiments with which this inquiry this year began. As already stated, it was begun in September, and, leaving out the earlier experiments, I passed on to October 30th. I have now to bring your attention back to the earlier experiments performed in the laboratory. They were suggested by the ingenious investigations of Dr. William Roberts, of Manchester, and by the subsequent investigation of a man to whom we are indebted more than to any other for the knowledge we possess of the different species of those small organisms that we call bacteria; I refer to Professor Cohn, of Breslau. Let me say that I entertain the very highest opinion of the intelligence and ability with which Dr. Roberts has carried out these experiments, they are in the highest degree creditable to him. This is the experiment to which I refer. Some chopped hay is put into a little can; it is raised to a temperature of 100 deg. to 120 deg.; it is kept for three hours, then poured off and filtered. Last year, we found that hay thus treated was sterilized by five minutes' boiling. I mean that, when it is exposed to the air that has this floating matter removed from it, it never shows any sign of microscopic life. Now, if you examine this natural hay-infusion with litmus paper, you will find that it turns the litmus paper red, showing that it is an acid infusion. Dr. Roberts found that acid infusions could be easily sterilized. He took a vessel with an open neck at the top and filled it two-thirds full with the infusion he wanted to operate upon; he then stuffed the neck with cotton-wool, and sealed it hermetically with a spirit-lamp above the plug of cotton-wool; he then placed it in a vessel containing cold water, and he gradually raised the water to a state of ebullition and maintained the boiling temperature for any required time. In that way he avoided all commotion, all evaporation, all ebullition in the infusion. After he had placed the tube in this condition in the water, and subjected it to a boiling temperature for any required time, he took it out and simply filed it across the neck and broke it off. Here you have the infusion practically exposed to the atmosphere. The plug intervenes to prevent the entrance of dust, and still allows an interchange between the air of the bulb and the air outside. When Dr. Roberts took this acid infusion and neutralized it by the addition of caustic potash, he found it to possess the most extraordinary power of resistance to heat; he found that, in some cases, it required more than two hours to reduce this infusion to sterility; he also found that, in a particular case, it actually required no less than three hours' boiling to produce this effect. This was very different indeed from the results that I had obtained last year. I made many experiments with hay-infusion, and in every case we sterilized it by five minutes' boiling. I was led to take up the subject this year through the emphatic manner in which Professor Cohn corroborated the results of Dr. Roberts. I operated sometimes with tubes like those of Dr. Roberts, and sometimes with those which I call Cohn's tubes. These are formed by heating a certain portion of a test-tube and drawing it out so as to leave an open funnel above, a bulb below, and a narrow tube between both. These are Cohn's tubes. His method was this: He placed the tubes, as they are placed here, in boiling water, and when they had been subjected to a boiling temperature for a sufficient time he simply lifted them out. He found a certain amount of water condensed upon the neck of the bulb; he waited one or two minutes until that evaporated, and then quietly plugged his tube with cotton-wool, and he thought that this was perfect immunity against the entrance of contamination; and Professor Cohn is very emphatic in saying that there is no thought of contamination from without in pursuing this method of experiment. I operated upon a great variety of hay-infusions, and after a time, by pursuing with the most scrupulous exactness the method laid down by Dr. Roberts and Professor Cohn, it was possible for me, by practice, now to corroborate and now to contradict them. It is perfectly useless to bring forward before public assemblies merely opposing assertions, so that I did not really content myself with falling back upon the results I obtained last year, but tried to get some knowledge as to whence the differences arose which showed themselves between me and these distinguished men. Here are tubes of alkalized hay, some of them subject to a boiling temperature, not for three hours, but for ten minutes, and they are perfectly brilliant; there is not the slightest evidence of life in them; they have been entirely sterilized by an exposure to a boiling temperature of ten minutes. If I illuminate them, you will find that these infusions are perfectly brilliant; there is no turbidity that gives any sign of the production of animalcular life. These tubes have remained there for three months perfectly intact, uninvaded by those organisms which were invariably found both by Dr. Roberts and by Professor Cohn. Again, we turn to another series of tubes, and find that every one of them has given way. Thus I went on ringing the changes, until, as I have said, it was in my power, by pursuing with undeviating fidelity the mode of experiment laid down by Dr. Roberts and Professor Cohn, to get at one time a contradiction and at another time a corroboration of their results.

And what was the meaning of these irreconcilable contradictions? The meaning was this: when we came to analyze these various infusions, we found that those that were sterilized by a boiling of from five to ten minutes were invariably infusions of hay mown in the year 1876, whereas the others were infusions of hay mown in 1875, or some previous year. The most refractory hay-infusion that I have ever found was in the case of some Colchester hay five years old. Now, what do these experiments point to? The answer may be in part gathered from an observation described in the volume of the *Comptes Rendus* for 1863 by one of the greatest supporters of the so-called doctrine of spontaneous generation. A description is there given of an experiment that was made by the wool-staplers of Elbeuf. They were accustomed to receive fleeces from Brazil which were very dirty, and had, amongst other things, certain seeds entangled in them. These fleeces were boiled at Elbeuf sometimes for four hours; and the seeds were afterwards sown by some of these expert fellows that had to deal with the fleeces, and were found capable of germination. The thing was taken up by Pouchet. He gathered these seeds, exposed them to the temperature of boiling water for four hours, and then examined them closely; and he found (and I recently made an experiment which showed the some thing to be true with regard to dried and undried peas) that the great majority of the seeds were swollen and disorganized, while the others were scarcely changed; they were so indurated and perhaps altered in the surface as to prevent the liquid from wetting them. At all events, a number of them appeared to be quite unchanged. He separated these two classes of seeds and sowed them side by side in the same kind of earth. The swollen seeds were all destroyed; there was no germination; but in the case of the others there was copious germination. Here, then, you have these seeds proved to be capable, by virtue of their dryness and induration, of resisting the temperature of boiling water for four hours. There is not the slightest doubt that, if time permitted, I could heap up evidence of this fact, that the wonderful sterility of this old hay is due to the induration and desiccation of the germs associated with it. Here you have three tubes containing cucumber infusion of crystalline clearness; they have been simply subjected to a boiling temperature for ten minutes; they have been completely sterilized, and they are as clear as when the infusions were first introduced into the tubes. On the other hand, here are tubes that have been subjected to a boiling temperature for five hours and a half showing a swarming development of life. What is the reason of this difference? The reason depends entirely upon the method of experiment. When Dr. Roberts filled his bulbs, he simply poured in his infusion, plugged his tube, sealed it, and subjected it to a boiling temperature. Not only did the liquid contain germs, there was a quantity of air above the liquid, and the germs were diffused in the air. Germs thus diffused in the air are very differently circumstanced from germs diffused in a liquid: they can withstand for hours a boiling temperature; whereas that selfsame temperature, brought to bear upon germs immersed in liquid, destroys them in a few minutes. And why do these tubes differ? The reason is to be sought entirely in the method of filling the tubes containing the clear infusions. Take one of Dr. Roberts' bulbs. You see that the top is united to a T-piece with a collar of india rubber. This comes down and ends in the neck of the bulb. Here is an air-pump, and here is the end of the T-piece surrounded by a tube of india rubber, and here is a pinchcock to close that tube of india rubber. If you open the pinchcock and work the air-pump with which this end is connected, it is completely exhausted. You may allow it to be filled with air; you may then open the pinchcock; the air will enter through the cotton-wool, and will fill the bulb. In this way you get the bulb filled, not with common air, but with filtered air. This process is carried on three or four times, so as to make sure that the common air has been displaced by the filtered air. We will suppose that I detach the tube from the air-pump and other precautions taken. At present you see the bulb is empty. Taking an infusion of hay, I put the end of the T-piece into the infusion to be introduced into the bulb. The bulb is dipped into hot water; the air expands, and it is driven out. Simply introducing our bulb into cold water, the air shrinks, and by atmospheric pressure the liquid is driven into the bulb. Again we drive the air out, and, by a few operations of this kind, we find that we can charge our bulb with a very great degree of accuracy. You can see the liquid in the bulb at the present time. In this way we charge a bulb which has had its common air and floating matter removed with our infusion. When it is charged, it is very carefully removed, and great precautions are taken so as to prevent any indraught of air. For instance, it is always removed from the cold water, so that, when it is lifted up into the air of the laboratory, a slight expansion shall take place, so that the motion of the air shall be from within outwards, instead of from without inwards. In that way we can, by careful manipulation, obtain bulbs devoid of this floating matter. These are the bulbs you now see before you showing this beautifully pellucid infusion.

Were this a biological investigation, and not a physical one, I should feel myself out of my element in dealing with it. I leave the determination of the species of bacteria to others far more competent than I am. I can see these organisms and wonder at them when I see them through the microscope; but I have no ability or knowledge to classify them and divide them into species, genera, etc. But these are purely physical experiments, and it is only by such severe experiments that this question can be freed from the haze and confusion in which it has been hitherto involved. Even the celebrated Professor Cohn—I say it with the greatest regard and respect for him—appears to have no adequate notion of the care necessary to be taken in experiments of this kind. To lift a tube out of the boiling liquid, and allow it to remain quietly in the air, the entry of the air taking place from without inwards, and then, after one or two minutes' exposure, to plug it with cotton-wool and say that no contamination can reach it, is in my opinion a great mistake. He could not, but by the merest accident, get an infusion free from contamination by operating in this way. I have here tubes prepared according to his method. Here are some melon-tubes all putrid, all gone into a state of fermentation. I ask you to compare those with some other melon-tubes that I have operated upon in a different way and that are as clear as crystal. The others are all gone, simply through a defect in the mode of manipulation.

The defeats that I at first described to you were due entirely to the contaminated atmosphere in which we worked. It ought to be noted that, in the earlier experiments in this inquiry, the results were always in accordance with those brought before you last year. By degrees, however, masses of hay were introduced into the laboratory—old hay and new hay from various places; and they ended by rendering the atmosphere so virulently infective that everything was contaminated by the germs set afloat. It resembled the case of a surgical ward of a hospital, where gangrene and putrefaction have attained such a predominance that the surgeon has in despair to shut up his ward and abandon it to disinfection. Desiring to free myself from this pestilential atmosphere, I wrote to my friend, the President of the Royal Society, Dr. Hooker, and I found that he was able to furnish me with a means of getting away from it. In Kew Gardens, there is a beautiful new laboratory, erected by the munificence of that most intelligent supporter of science, Mr. Thomas Phillips Jodrell. He, at his own expense, has had this beautiful laboratory built—being designed, I believe, by Dr. Thiselton Dyer. It is one of the neatest things I have ever seen, and it is to me a great gratification that the first experiments made in that laboratory were those to which I have now to refer. I broke away from the contaminated air of the Royal Institution. It is very well for you that I can tell you, that all the germs referred to are perfectly innocuous to human beings, for I have no doubt the air of this room is contaminated with them. A series of chambers was made—not of wood, for I wanted to get rid even of that, but of tin—and I would not allow Mr. Cotterell to carry those chambers into the Royal Institution at all. They were carried from the tinman's where they were made to the laboratory at Kew. There, with the greatest care, the tubes were treated first with carbolic acid and then washed with water, and then with caustic potash, to get rid of all traces of carbolic acid, and finally drenched with distilled water. Carbolic acid, as you know, is a deadly foe to these germs. In this way I hoped that every contamination that might be adhering to the tubes would be destroyed, and that, having got clear of an infected atmosphere, we might get the same results as we invariably obtained last year. The temperature was raised to between 80 deg. and 90 deg., and once a little above 90 deg., so that the warmth was all that could be desired for the development of those organisms. It gives me the deepest gratification to find that what was foreseen has occurred, and that this very day these chambers have come back from Kew perfectly intact. They comprise the most refractory substances that I had experimented upon here. It was almost impossible to save a cucumber; I never did succeed in saving a melon-infusion from contamination, and from this so-called spontaneous generation. But here, when the air had been allowed to deposit all its motes, and when we were withdrawn from an infected atmosphere, as I have said, the chambers were returned with their infusions as clear as crystal. Mr. Cotterell will show you some of them. You will see that one of these is muddy and turbid, and it has a deposit at the bottom. These are all dead bacteria, and the muddiness is due to swarming bacterial life. Here you have two infusions perfectly clear. Why did the other tube give way? When we came to examine it, a little pin-hole was found at the bottom of the chamber, and through that pinhole the germs got in. Here is a melon-infusion; and, in order to show you what would have occurred if the infusions had not been protected from the floating dust of the atmosphere, we have hung beside this case the two tubes that have been exposed to the common air and have fallen into a state of utter rottenness. In this way, from the Jodrell Laboratory at Kew, we have had these cases returned with their infusions perfectly intact. Even in our infected atmosphere, when we subject our infusions to experimental conditions sufficiently stringent, we are able entirely to shut out contamination, and to show that spontaneous generation never occurs. When we get clear of our atmosphere altogether, this is a matter of perfect ease and facility; and we find in Kew Gardens that nature runs her normal course.

COURSE OF THE SAP IN PLANTS.

AT the last meeting of the Scientific Committee of the Royal Horticultural Society, Mr. Andrew Murray read a paper combatting the theory of a descending current of sap at any period or under any circumstances. He maintained that absolutely no proof whatever has hitherto been adduced of a descent of sap. Nor would he admit of an assimilating process in the leaves and a transference of food thus prepared to where growth is taking place, or where, under certain conditions, growth would take place. His view he believes to be supported by the results of experiments conducted by Mr. Herbert Spencer (Linnean Society's Transactions, vol. xxv), and since repeated and extended by Prof. W. R. McNab. It is essentially this, that the ascending sap deposits the wood as it rises, and the surplus water returns to the atmosphere through the leaves. Mr. Murray concluded with an appeal for a re-investigation of the subject.—*Academy.*

HOME-MADE CORALS.—The manufacture of napoline, an imitation of coral, is being carried on by a Connecticut firm. It is, it is said, made from cheese or curds. The curd is separated from the water by chemicals and drying, subjected to a 40-tons pressure, and cut into the shapes of flowers, etc., being capable of receiving any color.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

Second Series.

No. VII.

In Fig. 46, we illustrate a form of link well suited for light work, such for instance as operating the valve gear of a steam engine of moderate dimensions, and differing in detail from those previously described. The right hand end is provided with brasses, a strap and a key; but the gib is absent, its place being supplied by a bolt which binds the sides of the strap together. The brasses, too, differ from those before shown in this respect, that they are not provided with flanges, but are flush with the sides of the rod and strap. It will not have escaped the notice even of the reader not previously familiar with such details, that those projecting flanges, embracing the sides of the stub-end and of the strap, served an important purpose in preventing any tendency to lateral motion; to be sure, the gib and key helped, and in this case the key alone would, so far as it could, tend to keep the strap in its place, but the brasses, if simply bounded by parallel and perpendicular plane surfaces, would be free to work out sidewise. In order to prevent this, and also to keep the strap itself from moving in a similar manner on the rod, without depending wholly on the bolt and the key, the inside of the strap is not slotted straight across, but is formed with a slight bevel, being deeper in the center than at the edges, and the upper and lower sides of the brasses and of the stub-end have grooves of a corresponding form in them. This is indicated by the dotted lines in the front view, and in a working drawing, in which the center line is drawn in light red, the edge of this groove will also appear in the top view. But in order to make assurance doubly sure, and to have no possible chance of misunderstanding, it is advisable to make a transverse section, as shown at A on the right. This section may, and it is better that it should, be supposed to be made not precisely through the vertical center line of the pin, as seen in the front and top views, but a very small distance to the left of it. Thus we shall see not only a section of the strap, which, being of wrought iron, would be sectioned in blue, but of the brass itself, which will be sectioned in red; which gives a more complete explanation, at a glance, of the whole arrangement than if the strap alone be shown in section. It is not necessary to show the thicker part of the strap, which, since the view A is taken as looking to the left, would actually be visible. A considerable license is allowed in regard to such matters; we claim that it is not obligatory to show anything beyond the plane of section, but that we may show whatever we please that is seen beyond it; that we may introduce or omit according to circumstances, being guided in our selection by the consideration so often mentioned, that the drawing shall be, first of all, clear and explanatory. We are aware that many draftsmen differ from us in this respect in practice, whatever their favorite convictions may be as to the theory; and have seen those who would insist on putting in the key and the bolt, dotting the parts not seen. If any of our readers has a little time for which he can find no better use, he may try the experiment of constructing the view A in that manner; and we are confident that the result will satisfy him of the futility of repeating it.

The bolt here used is a tap-bolt, screwed into the lower side of the strap, through which it projects, being furnished with a jam-nut. When the key is driven down, the whole strap advances to the left, carrying the bolt with it, whence it is necessary to make the hole through the stub-end elongated, to permit this motion of the bolt; which form of the hole is to be indicated in the top view, as well as by the dotted line at the left of the bolt in the front view. The key is secured from backing out by a set-screw in the manner before described, which is a very good mode when the head of the screw is not in the way; other devices for the same purpose, which can be used where such a set-screw would be inadmissible, will be shown hereafter.

The determination of the increased thickness of the strap, to compensate for the weakening due to the slot for the key and the hole for the bolt, needs no explanation; but it is to be observed that, if the bolt fit the hole perfectly, the whole of the strap behind the key may be regarded as intact, since the key could not split out a part of the strap without shearing off the bolt at the same time; but usually this will take care of itself in a way, because the bolt must be at a convenient distance from the key, and not too near the end of the strap, so that, these things being attended to, there will in consequence be ample security against such splitting.

The key itself, it is needless to say, must do the whole duty, or almost the whole; the friction between the rod and strap helped a little, but the key should be made nearly wide enough to bear the whole pull of the rod.

The crown brass, in small rods like this, is very frequently made square, as in the figure, instead of having its corners cut off and its flange (if it have one) rounded, and the strap of course is made to correspond. In this case the end of the strap is made thicker than the sides, as shown, in order that when the link pulls, instead of pushing, the pressure may be uniformly distributed over the outer face of the crown brass.

The other end of the link is fitted up in an entirely different manner, being, in fact, merely an eye formed by making a hole for the pin through the end. But brasses are introduced here too, though they do not entirely embrace the pin, but only the parts of its surface near the center line of the link; which parts, however, receive the direct pressure. It will therefore be seen that this arrangement is better adapted for use in cases where there is only a small motion of rotation of the link on the pin—as, for example, where an arm on a rock-shaft is to be moved back and forth through a small arc—than it is when the pin turns entirely round in the eye, as in the case of a crank turning round and round. These brasses are of such breadth and thickness that they can be introduced endwise into the eye of the link, and then pushed in the direction of the center line into the recesses slotted out for them in the body of the rod. The lost motion is taken up by a set-screw tapped into the end of the link, which is further provided with a jam-nut to prevent its backing out. This set-screw should be quite large, and its end made perfectly flat, so as to bear fairly on as large a part of the surface of the crown brass, as we may still call it, as possible.

The brasses at this end also are dovetailed in, to prevent any tendency to work out sidewise—although it is hardly necessary to say that this, in many cases, would be needless, that possibility being prevented by collars on the pin.

But when it *is* to be done, it is well to introduce the end view, B; and, in fact, it is as well to do it in all cases, because the thickness of the rod, to which it is to be planed, must be shown in some way, and this view indicates it just as well as a top view would, if not better, and it is more easily drawn.

The determination of the curve of intersection, at this end of the link, needs no explanation, being in no respect different from examples already fully discussed.

At the other end, however, we have something which at first sight appears to be a new state of things, in the fact that the faces of the shallow V-shaped grooves in the upper and lower sides of the rod are not, like the others, parallel or perpendicular to the paper, so that their intersections with the turned part would seem to be different from anything yet described. On reflection, however, it will be seen that the difference is actually one of position only; for the faces of these grooves are planes, parallel to the axis, and we know their distances from the axis. Were they parallel or perpendicular to the paper, then the intersections could be readily constructed, and we might leave such construction and a subsequent revolution, with the drawing of them in their new positions, as exercises in the application of principles which, though not certainly elementary, are, nevertheless, not very abstruse, and have been illustrated.

But the curve may be drawn as it appears in its true position by a process which really involves all that is comprised in the two above mentioned, although by reason of the fact that no record is kept of the intermediate steps, the final results only appearing on the drawing, it seems much shorter, and indeed really is so, in respect to the time required for its execution. This we illustrate in Fig. 47, in which, however, the peculiarities of the conditions are much exaggerated, for the reason that in the practical case given in Fig. 46, the curves are so short and the curvature so slight, that they do not exhibit their features in as pronounced and clear a manner as is desirable.

In Fig. 47, the rod is turned to the outline shown by the circular arc, $a\,c$, whose center is p; the side of the stub-end is then planed to the line L L in the end view, after which the V-shaped groove shown in the latter view is made. The stub-end was of rectangular section at first, its upper face being d D, $d'\,d''$; and we have seen before that the point d is found by revolving d' about C to the vertical center line at e', projecting e' to e in $a\,c$, and dropping the perpendicular $e\,d$. Now, the point o', on the line $d'\,f'$, which represents one face of the V groove, may be regarded as a corner of a smaller rectangle—as if the stub-end were to be reduced in both breadth and thickness. Were that to be done, we should find the point o corresponding to it in the side view,

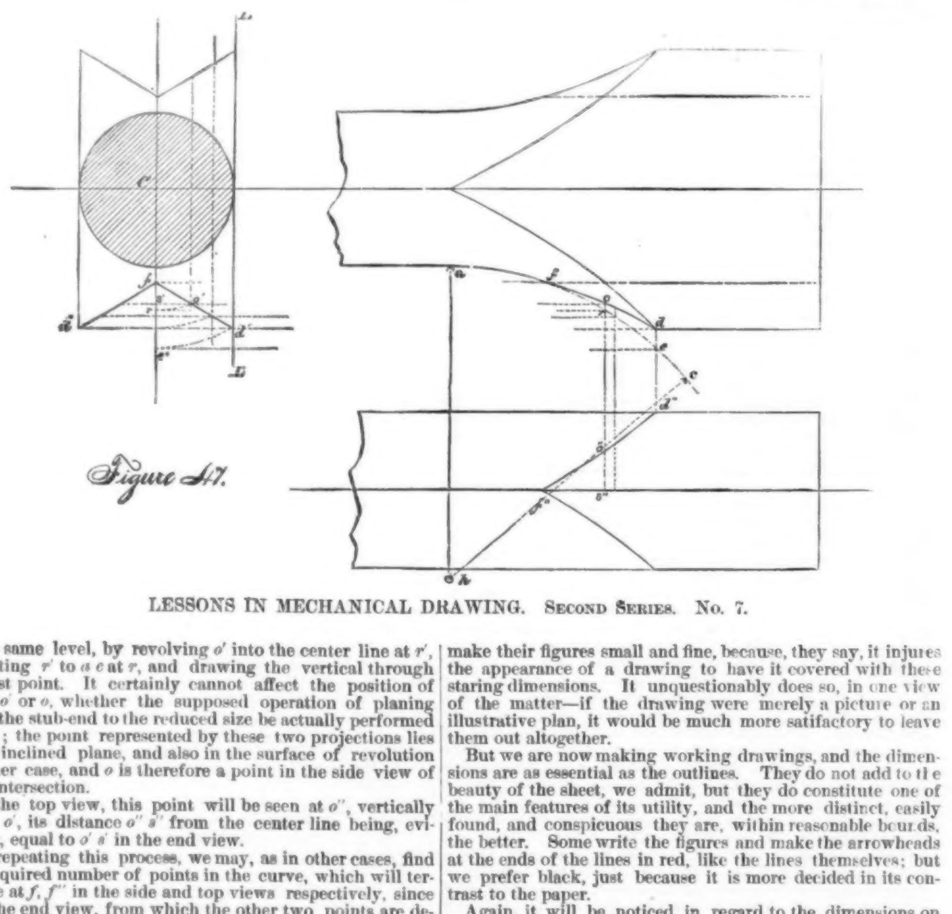


Figure 47.

LESSONS IN MECHANICAL DRAWING. Second Series. No. 7.

on the same level, by revolving o' into the center line at r', projecting r' to $a\,c$ at r, and drawing the vertical through this last point. It certainly cannot affect the position of either o' or o, whether the supposed operation of planing down the stub-end to the reduced size be actually performed or not; the point represented by these two projections lies in the inclined plane, and also in the surface of revolution in either case, and o is therefore a point in the side view of their intersection.

In the top view, this point will be seen at o'', vertically under o', its distance $o''\,s''$ from the center line being, evidently, equal to $o'\,s'$ in the end view.

By repeating this process, we may, as in other cases, find any required number of points in the curve, which will terminate at f, f'' in the side and top views respectively, since f' in the end view, from which the other two points are derived, is on the center line, which there represents the meridian plane of the outline $a\,c$.

The intersection of the side plane, L L, with the solid of revolution is, of course, unaffected by the existence of the other curve just determined, and is constructed in the usual manner; we therefore omit all steps in the process, as their introduction would tend to confuse the diagram—the curve itself is, however, shown in the side view, intersecting the new one at d, the point in which the upper edge, d D, of the stub-end pierces the turned part of the rod.

Nor must we neglect the intersections of the inclined faces of the groove and strap, with the plane faces of the slot for the key and the cylindrical surface of the hole for the bolt. The former will of course be right lines; the latter, since the cylinder is cut by an inclined plane, will be parts of ellipses. These the student should be able to construct for himself, and we accordingly omit the detail of the operation, giving only the hints, that the readiest means of doing it will be by the aid of an end view, which, however, need not be drawn on the sheet, but may be made on any loose bit of paper at hand, and that, in the case of the elongated hole for the bolt through the stub-end, the intersection will consist of two quarter-ellipses, joined by a right line; because the hole itself is made by drilling two round holes and cutting out the metal between them, forming, in fact, two half-cylinders joined by tangent planes.

We wish now to call attention to the "figuring" of these drawings. In an engraving it is, of course, necessary to do everything in black, and the introduction of so many "dimension lines" makes our illustrations appear much more complicated, not to say confused, than they will when the reader copies them as they are intended to be copied; that is, using different colors as heretofore suggested. The center lines being drawn full, the dimension lines dotted, but both in red, the eye will be greatly relieved, and the drawing much more easily understood. In regard to these dimension lines, it is to be noted, first, that they are not continuous. By this we do not mean merely that they are dotted, but that a blank space is left, in which the dimensions are written, not on the level of the line but a little below it; so that, if the line *were* drawn continuously, it would pass through the middle of the figures.

Some draftsmen do not regard this, but make a continuous line, and write the figures either on it or a little above or below it. Were this merely a matter of taste we should not lay so much stress upon it, although holding a very decided private opinion in regard to it *as* a matter of taste. But we insist upon it that this is something of more moment, and that the mode advised adds greatly to the distinctness of the figuring; and we merely suggest that any of our readers who doubts this shall try the experiment fairly. If, then, it does facilitate the reading of the drawing in any degree, it is an important item; the draftsman is morally bound to do his utmost to prevent mistakes and to save time in the shop; and, next to making clear and accurate drawings, clear and intelligible figuring of them tends to these results.

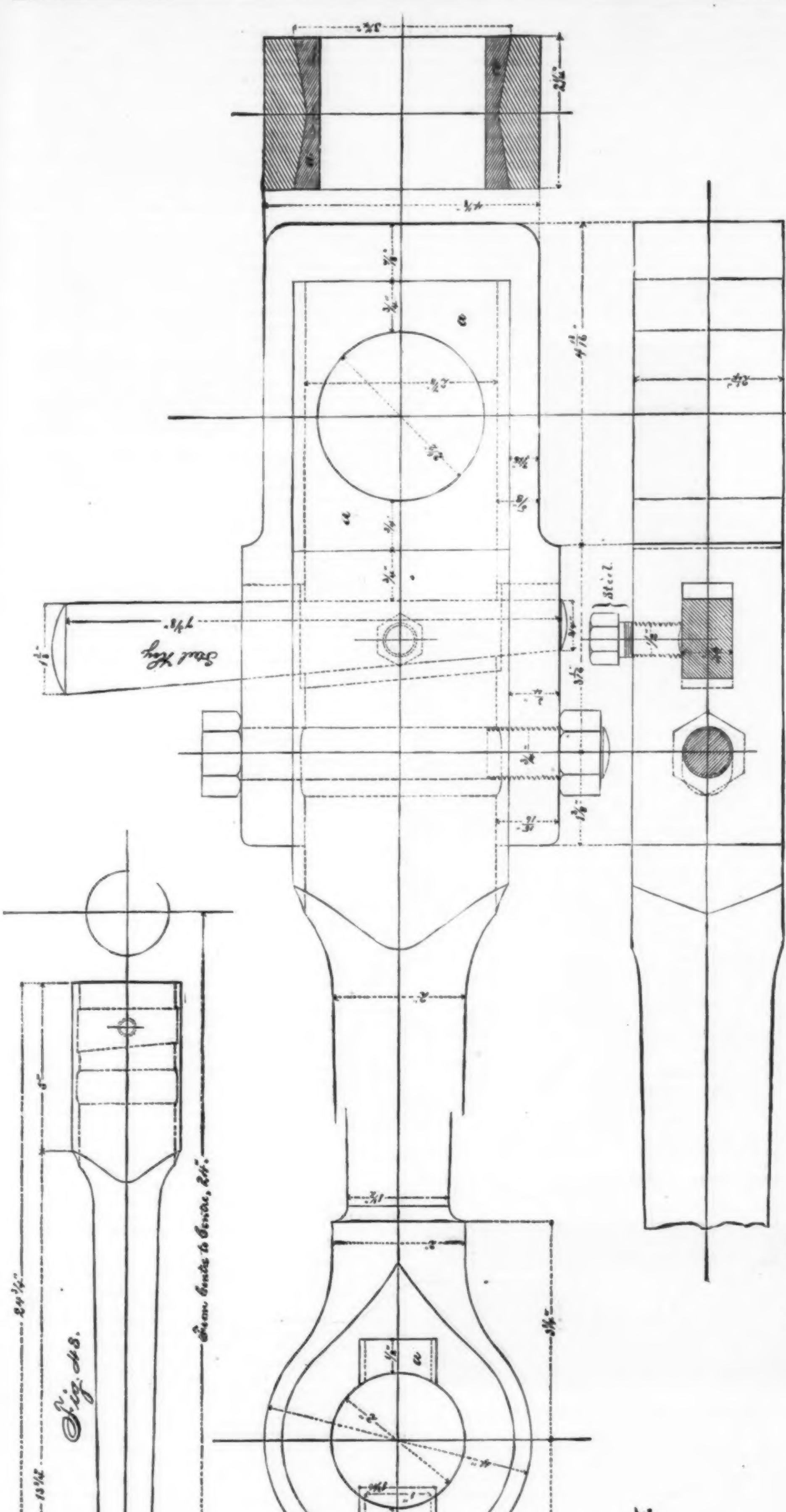
It is to be observed also that the center lines are not made to do double duty by serving also as dimension lines. That, we regret to say, they are too often compelled to do; but it is a bad practice, since those lines are drawn full, for one thing, so that the figures must be written above or below them; and, besides, attention is not called to the dimensions in as aggressive a manner as it is when they are provided with lines for themselves.

And this is just what is wanted: the workman should not have to scrutinize the drawing and hunt for the figures, but they should force themselves into notice. The dimension lines should therefore not be close to either center lines or outlines unless it is absolutely necessary. The figures themselves should be written neatly, boldly, and, above all things, distinctly.

In regard to this, we do not by any means intend to commend the examples given in our illustrations as guides for our readers, who will, we hope, follow rather our precepts than our practice. Now we know that many are inclined to make their figures small and fine, because, they say, it injures the appearance of a drawing to have it covered with these staring dimensions. It unquestionably does so, in one view of the matter—if the drawing were merely a picture or an illustrative plan, it would be much more satifactory to leave them out altogether.

But we are now making working drawings, and the dimensions are as essential as the outlines. They do not add to the beauty of the sheet, we admit, but they do constitute one of the main features of its utility, and the more distinct, easily found, and conspicuous they are, within reasonable bounds, the better. Some write the figures and make the arrowheads at the ends of the lines in red, like the lines themselves; but we prefer black, just because it is more decided in its contrast to the paper.

Again, it will be noticed in regard to the dimensions on vertical lines, that they are all written in one way, thus, and not in the other direction, in any instance. Perhaps it would not make a great deal of difference which of these ways were adopted, provided that one mode be rigidly adhered to throughout; still, the former one is evidently the most natural, as being the most convenient for a right-handed individual, if it were necessary for him to write the figures on the vertical lines while standing at the front of the drawing-board, in which case he would turn his right side toward it in order to have the free use of his hand and arm. This being the case, one instinctively turns the head to the left on seeing a figure written upon a vertical line, taking it for granted that it was written in that manner under such circumstances. And nothing is more perplexing and annoying than to have some figures written in one direction, some in another, unless, indeed, it be to have some of those on the horizontal lines upside down. Even this we have seen in working drawings—the draftsman consulting his own ease first, and walking round the board, writing whichever way he found most convenient. Some, again, compromise matters by writing all the figures so as to be read from the bottom of the sheet, that is, as though they were all on horizontal lines, simply putting the figure for a vertical dimension in an open space of the vertical dimension line. This fails in one particular—attention is not called to the fact that it is a vertical dimension by the position of the figure itself, as it should be, and as it is in the mode recommended. The above are a few of the leading points in relation to this, which is



LESSONS IN MECHANICAL DRAWING. SECOND SERIES. No. 7.

an important matter. We shall have occasion subsequently to mention others as they arise; in the meantime we may refer to Figs. 41 and 42 as illustrating tolerably well what we consider a judicious arrangement of the dimension lines and the figures in similar drawings.

The shank or body of the link, of which the ends are shown in Fig. 46, is not of uniform size, but larger at one end than the other. In this instance the link being a short one, it is made with a direct taper, there being no swell in the middle, so that the outline is merely a straight line tangent to the curves bounding the necks at the two ends. Now it is not by any means necessary to make a full-size drawing of all this. The two ends, of course, ought to be drawn full-size; as for the intermediate shank, it *need* not absolutely be drawn at all in a case like this, as it would answer all practical purposes if a little of the straight part be shown at each end, as in the figure, and a note or written direction be appended to the drawing, explaining the form. But it is better to make a drawing, on a reduced scale, showing the body of the link entire, as in Fig. 48. This need not contain a repetition of the straps and other small details, but should exhibit the formation of the shank completely, including the slots, holes for set screws, and, in short, every particular relating to the body of the link, as seen in the view selected. This is usually the side view, which under all ordinary circumstances is sufficient, as the peculiarities of the ends are shown in the full-size drawings; for which reason also it is unnecessary to repeat the figures on those parts; the dimensions given in Fig. 48 are all that are required. The pin, or a circle of the proper size representing it, should be drawn, its center being correctly located, and the distance from center to center marked in, as well as the extreme length of the shank of the link itself.

It will readily be seen that such a drawing, made carefully to scale, gives at a glance a more perfect idea of the general form and proportions than any note or verbal instruction can convey; and this is one reason, and a very good one, for making it. The workman, though dealing with the details of which the whole is made up, nevertheless derives great aid, and can proceed much more rapidly, intelligently, and satisfactorily, from having a clear idea of how the complete article in hand will look; and the little time required for the draftsman to make such a scale drawing will be more than saved in the shop before the work is finished, to say nothing of the fact that it is almost necessary for the designer to have each part drawn to scale, in order to make sure that all things are in correct and harmonious proportion.

VEGETABLE DIGESTION.

SINCE the discovery of the remarkable phenomena connected with the absorption of their food by so-called "carnivorous plants," the view has been rapidly gaining ground that there is in reality but little essential difference between the processes of the assimilation of food by plants and by animals. Professor Calderon, of the Institute of Las Palmas, Canary Isles, has lately propounded the idea that plants do not, as is usually supposed, derive their nitrogen entirely from the nit ates and ammoniacal salts dissolved in the soil, but to a considerable extent also from the nitrogenous organic matter which is always floating in the air in a solid form. The purpose of the viscid hairs or glutinous secretion with which so many plants are provided, he believes to be the detention of this floating organic matter. To prove the importance of the solid particles floating in the air to the life of the plant, he deprived air of all its organic matter in the way described by Professor Tyndall, and subjected some lichens to the access only of this filtered air and of distilled water, when he found all their physiological functions to be suddenly suspended. Professor Calderon divides the nutrition of plants into three classes: (1) *necrophagous*, the absorption of dead organic matter in various stages of decomposition; (2) *plasmophagous*, the assimilation of living organic matter, without elimination or distinction of any kind between useful and useless substances such as the nutrition of parasites; and (3) *biophagous*, the absorption of living organisms, such as that known in the case of insectivorous plants.

Professor Ed. Morren, of Liége, has contributed an important paper on vegetable digestion to the proceedings of the Royal Academy of Belgium. He commences by the assertion that digestion is not a function peculiar to "carnivorous plants," but that it is common to all living beings, vegetable as well as animal. Animal digestion is, he states, according to the most recent observations, a fermentation consisting essentially in a hydration, or transformation of colloids into crystalloids, this change being a necessary preliminary to absorption. It is caused by the action of certain substances known as ferments, which are especially abundant in particular secretions, such as the saliva, gastric juice, and pancreatic juice. In the same manner all plants digest, and the process is precisely analogous to that of animals, being in this case also essential before assimilation is possible. Such a transformation of a colloid into a crystalloid is illustrated in the ordinary change of starch into glucose, which takes place so commonly in plants; the active ferment in this case being diastase, which has been detected in barley, as also in the potato.

$$\underbrace{2(C_6H_{10}O_5)}_{\text{Starch.}}+H_2O=\underbrace{C_6H_{10}O_5}_{\text{Dextrine.}}+\underbrace{C_6H_{12}O_6}_{\text{Glucose.}}$$

$$\text{or } C_6H_{10}O_5+H_2O=C_6H_{12}O_6.$$

But, for the fermentation or digestion of albuminoids and other nitrogenous substances, a different ferment is required, and this we have in pepsine, which has been detected by Riess and Will, and other observers, in the viscid secretion of *Nepenthes*, *Drosera*, and other insectivorous plants. A similar substance has been observed in the latex of *Carica Papaya*, and elsewhere in the vegetable kingdom. It seems probable in fact, digestion is as widely diffused a phenomenon, and as various in its forms, among plants as among animals. It consists essentially in the transformation of the raw insoluble food-material (a colloid such as starch) into soluble crystalloids capable of assimilation. The process takes place chiefly in the reservoirs of reserve material, such as seeds, bulbs, tubers, roots, the pith, and the bark; the nutrition of plants is, therefore, made up of three successive processes:—(1) elaboration, or the production out of its elements of carbohydrates, which can take place only under the influence of light; (2) digestion, consisting essentially in a hydration, such as the conversion of starch into glucose associated commonly with evolution of carbonic acid, and accompanied by a molecular change which renders the product soluble and diffusible; and (3) assimilation, the absorption into the tissue of the substances thus prepared, accompanied usually by a loss of water, and the reversion of glucose to the condition of cellulose—a substance isomeric but not isomorphic with starch—and the consequent production of the cell-wall.—*Pharmaceutical Journal.*

FORMATION OF RAINDROPS AND HAILSTONES.*

When the particles of water or ice which constitute a cloud or fog are all of the same size, and the air in which they are sustained is at rest, or is moving uniformly in one direction, then these particles can have no motion relatively to each other. The weight of the particles will cause them to descend through the air with velocities which depend on their diameters, and since they are all of the same size, they will all move with the same velocity.

Under these circumstances, therefore, the particles will not traverse the spaces which separate them, and there can be no aggregation so as to form raindrops or hailstones.

If, however, from circumstances to be presently considered, some of the particles of the cloud or fog attain a larger size than others, these will descend faster than the others, and will consequently overtake those immediately beneath them; with these they may combine so as to form still larger particles which will move with greater velocity, and more quickly overtaking the particles in front of them will add to their size at an increasing rate.

Under such circumstances, therefore, the cloud would be converted into rain or hail accordingly as the particles were water or ice.

The size of the drops from such a cloud would depend simply on the quantity of water suspended in the space swept through by the drop in its descent; that is to say, on the density and thickness of the cloud below the point from which the drops started.

The author's object is to suggest that this is the actual way in which raindrops and hailstones are formed. He was first

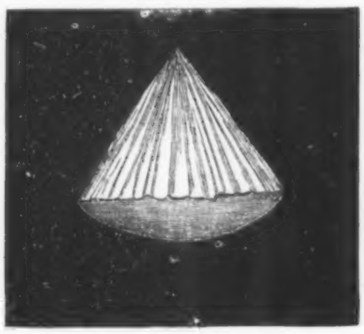


Fig. 1.—Perfect Hailstone.

led to this conclusion from observing closely the structure of ordinary hailstones. Although to the casual observer hailstones may appear to have no particular shape except that of more or less imperfect spheres, on closer inspection they are seen all to partake more or less of a conical form with a rounded base like the sector of a sphere. In texture they have the appearance of an aggregation of minute particles of ice fitting closely together, but without any crystallization such as that seen in the snow-flake, although the surface of the cone is striated, the striæ radiating from the vertex. Such a form and texture as this is exactly what would result if the stones were formed in the manner described above. When a particle which ultimately formed the vertex of the cone, started on its downward descent and encountered other particles on its lower face, they would adhere to it, however slightly. The mass, therefore, would grow in thickness downwards; and as some of the particles would strike the face so close to the edge that they would overhang, the lower face would continually grow broader, and a conical form be given to the mass above.

When found on the ground the hailstones are generally imperfect; and, besides such bruises as may be accounted for by the fall, many of them appear to have been imperfect before reaching the ground. Such deformities, however, may be easily accounted for. The larger stones fall faster than those which are smaller, and consequently may overtake them in their descent; and then the smaller stones will stick to the larger and at once deform them. But, besides the deformation caused by the presence of the smaller stone, the effect of the impact may be to impart a rotary motion to the stone, so that now it will no longer continue to grow in the same manner as before. Hence we have causes for almost any irregularities of form in the ordinary hailstone.

It appears from the numerous acounts which have been

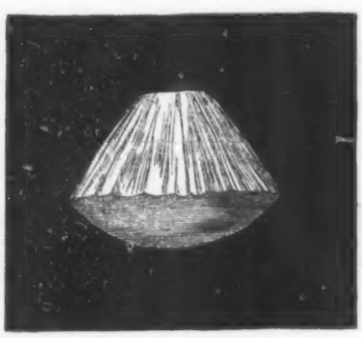


Fig. 2.—Broken Hailstone.

published that occasionally hailstones are found whose form is altogether different from that described above. These, however, are exceptional, and to whatever causes they may owe their peculiarities these causes cannot affect the stones to which reference is here made.

Again, on careful examination it is seen that the ordinary hailstones are denser and firmer towards their bases or spherical sides than near the vertex of the cone, which latter often appears to have broken off in the descent. This also is exactly what would result from the manner of formation described above. When the particle first starts it will be moving slowly, and the force with which the particles impinge upon it will be slight, and, consequently, its texture loose; as, however, it grows in size and its velocity increases, it will strike the particles it overtakes with greater force, and so drive them into a more compact mass. If the velocity were sufficient, the particles would strike with sufficient force to adhere as solid ice, and this appears to be the case when the stones become large—as large as a walnut, for instance.

An idea of the effect of the suspended particles, on being overtaken by the stone, may be formed from the action of the particles of sand in Mr. Tilghman's sand-blast, used for cutting glass. The two cases are essentially the same, the only difference being that the hailstone is moving through the air, whereas, in the case of the sand-blast, the object which corresponds to the stone is fixed, and the sand is blown against it.

By this sand-blast the finest particles of sand are made to indent the hardest material, such as quartz or hard steel; so that the actual intensity of the pressure between the surface of the particles of sand and that of the object they strike, must be enormous. And yet the velocity of the blast is not so much greater than that at which a good-sized hailstone descends. It is easy to conceive, therefore, that the

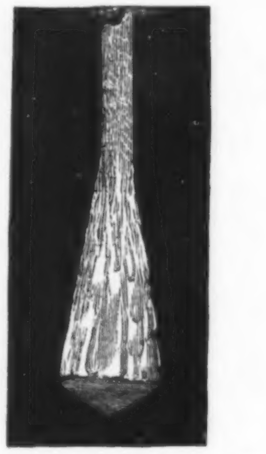


Fig. 3.—Imitation in Plaster of Paris.

force of the impact of the suspended particles of ice, if not much below the temperature of freezing on a large hailstone, would drive them together so as to form solid ice. For the effect of squeezing two particles of ice together is to cause them to thaw at the surface of contact, and as soon as the pressure is relieved they freeze again, and hence their adhesion.

It is then shown that hailstones, such as those described, can neither be formed by the freezing of rain-drops, nor by the condensation of vapor on a nucleus of ice; and that it is impossible that the particles of ice can have been drawn together by electrical attraction—their conical shape, and the increase in their density towards their thicker sides clearly showing that the particles have aggregated from one direction, and with an increasing force as the size of the stone has increased.

The possibility of making artificial stones is thus considered: If a stream of frozen fog were driven against any small object, then the frozen particles should accumulate on the object in a mass resembling a hailstone. Not seeing his way to obtain such a stream of frozen fog, the author thought it might be worth while to try the effect of blowing very finely powdered plaster of Paris. He therefore introduced a stream of this material into a jet of steam, issuing freely into the air (which he hoped would moisten the powdered plaster sufficiently to cause it to set firmly into whatever form it collected). The jet was directed against a splinter of wood.

In this way masses of plaster very closely resembling hail-

Fig. 4.—Imitation in Plaster of Paris.

stones were obtained. They were all more or less conical, with their bases facing the jet. But, as might be expected, the angles of the cones were all smaller than those of the hailstones. Two of these figures are shown in the sketches annexed.

The striæ were strongly marked, and exactly resembled those of the hailstone. The bases also were rounded. They were somewhat steeper than those of the hailstone; but this was clearly due to the want of sufficient cohesive power on the part of the plaster. It was not sufficiently wet. Owing to this cause also it was not possible to preserve the lumps when they were formed, as the least shake caused them to tumble in pieces.

Similar masses were also obtained by blowing the vapor of naphthaline, but these were also very fragile. Whereupon it is remarked: At ordinary temperatures the powdered naphthaline does not adhere like ice when pressed into a lump. No doubt at very low temperatures ice would behave in the same way; that is to say, the particles would not adhere from the force of impact. Hence it would seem probable that, for hailstone to be formed, the temperature of the cloud must not be much below freezing point.

That the effect of the temperature of the cloud exercises great influence on the character of the hailstones cannot be doubted. And if, as has been suggested by M. L. Dufour, the particles will sometimes remain fluid, even when the temperature is as low as 0° F., it is clear that, as they are swept up by a falling stone, they may freeze into homogeneous ice either in a laminated or crystalline form.

The author then proceeds to show that raindrops are probably formed in the same way as hailstones; that although the raindrops have no structural peculiarities like the hailstones, the aggregation of the particles of water by the descent of the drop through the cloud is the only explanation which will account for them. He shows that, as Mr. Baxendell had previously pointed out, the amount of vapor which a cold drop could condense before it becomes as warm as the vapor would be inappreciable when compared with the size of the drop, and since, in order that there might be condensation, the air must be warmer than the drop, the drop could not part with its heat to the air. He also shows that during the time of descent of a large drop, the heat lost by radiation would not account for the condensation of sufficient vapor to make any appreciable difference in the size of the drop. Whereas if we suppose all the vapor which a body of saturated air at 60° F. would contain over and above what it would contain at 32° to be changed into a fog or cloud; then if a particle, after commencing to descend, aggregated to itself all the water suspended in the volume of air through which it swept, the diameter of the drop after passing through 2,000 feet would be more than an eighth of an inch, and after passing through 4,000 feet a quarter of an inch, and so on. So that, in passing through 8,000 feet of such cloud, it would acquire a diameter of half an inch.

The fact that raindrops never attain the size of large hailstones is explained as being due to the mobility in the case of large drops of the surface tension of the water, by which alone the drop retains its form, to withstand the disturbing force of the air rushing past; when the drop reaches a certain size, therefore, it is blown in pieces like the water from a fountain.

The origin of drops and stones is then discussed—why some of the particles in a cloud should be larger than the others, as it is necessary for them to be in order that they may commence a more rapid descent. A cloud does not always rain; and hence it would seem that in their normal condition the particles of a cloud are all of the same size and have no internal motion, and that the variation of size is due to some irregularity or disturbance in the cloud.

Such irregularity would result when a cloud is cooling by radiation from its upper surface. The particles on the top of the cloud being more exposed would radiate faster than those below them, and hence they would condense more vapor and grow more rapidly in size. They would therefore descend and leave other particles to form the top of the cloud. In this way we should have in embryo a continuous succession of drops.

Eddies in the cloud also form another possible cause of the origin of drops and stones.

* Abstract of paper "On the Manner in which Raindrops and Hailstones are Formed," by Prof. Osborne Reynolds, M.A., read at the Literary and Philosophical Society, Manchester.

APPEARANCE OF A NEW STAR.

On November 24, at 5h. 41m. P.M., the director of the Observatory at Athens, Prof. Schmidt, remarked a star of the third magnitude not far from ρ Cygni, which was not visible on November 20, the last clear evening previous. Its position from observations with the refractor was found to be in R.A. 21h. 36m. 50·5s., N.P.D. 47° 40′ 34″ for the beginning of the present year. At midnight its light was more intense than that of η Pegasi, which is rated a third magnitude by Argelander, and very yellow.

Direct intimation of this discovery was given by Prof. Schmidt to M. Leverrier, and the Paris *Bulletin International* of December 6 contains the few particulars concerning this star which the generally unfavorable weather up to that date had permitted to be put upon record. M. Paul Henry estimated it of the fifth magnitude, so that, as in the cases of the similar suddenly visible stars of 1848 and 1866, it would appear to have remained but a very short time at a maximum. He considered the color "greenish, almost blue," by comparison with Lalande 42,304, not far distant. M. Cornu examined it on December 2 with a spectroscope applied to the great equatorial, though only during a short break; the spectrum was chiefly formed of bright lines, and consequently proceeded probably from a vapor or incandescent gas. On the same evening, but under conditions equally unfavorable, M. Cazin made similar observations with a spectroscope on the 9-inch Foucault equatorial, and with the same result. On December 5 M. Cornu succeeded in making several measures, though still much interrupted by clouds.

There is a slight confusion about the declination of this star, which, according to the lithographed *Bulletin*, M. Paul Henry made three minutes less than Prof. Schmidt, while the declination, as reduced by the latter to 1855·0, differs more than a minute from his declination for 1876·0, correctly carried back.

The remarkable star of 1866 (T Coronæ Borealis) descended to the limit of unaided vision in ten days from its discovery by Mr. J. Birmingham, of Millbrook, Tuam, on the night of May 12, when it appears to have become suddenly visible as a star of the second magnitude; it is now a little over the eleventh magnitude in Bessel's scale extended.

The similar object of 1848, detected by Mr. Hind on the morning of April 28, then of the sixth magnitude, and certainly less than the ninth on April 4 and 5, attained its maximum about May 7, and at that time was a little brighter than 20 Ophiuchi, rated a fifth magnitude by Argelander. The maximum brilliancy assigned to this star in Schönfeld's last catalogue is one magnitude too low. It continued visible without the telescope to the end of May. Last summer it was not over the thirteenth magnitude.

[By observations at Mr. Bishop's observatory, Twickenham, on the 12th December, 1876, the position of the new star for 1876·0 is in R.A. 21h. 36m. 50·35s. N.P.D. 47° 43′ 4″; Prof. Schmidt's declination is in error. The star was of the seventh magnitude, and colorless; the sky, however, very indifferent.]—*Nature.*

THE INTRA-MERCURIAL PLANET.

In M. Leverrier's last communication to the Paris Academy on the planet assumed to exist within the orbit of Mercury, it was mentioned that, with the elements adopted, or very similar ones, a solar conjunction would occur on March 22, and a transit over the sun's disk was possible, though uncertain. A close examination of the disk is therefore to be recommended on March 22 and 23, and there is reason to believe that observers in widely differing longitudes are prepared to undertake it. If no transit should then occur, eight or nine years may elapse before one is possible at the spring node.

"The Aubeltype Process," invented by Aubel, of Cologne, by which can be obtained good typographic reproductions of engravings, consists in preparing a photographic negative on glass with a salt of silver, and depositing more silver in the battery. The silvered plate is subjected to the fumes of hydrofluoric acid, which cuts away the parts unprotected by metal, and so prepares the matrix of the plate.